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FLOOD INSURANCE STUDY

ORIGINAL

CITY OF BELLEVUE, NEBRASKA
SARPY COUNTY

REVISED:
JUNE 4, 1987

Federal Emergency Management Agency

COMMUNITY NUMBER 310191

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NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

This publication incorporates revisions to the original Flood Insurance Study. These revisions are presented in Section 9.0

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Flood Boundary and Floodway Map Index
Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

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FLOOD INSURANCE STUDY

CITY OF BELLEVUE,
SARPY COUNTY, NEBRASKA

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Flood Insurance Study is to investigate the existence and severity of flood hazards in the City of Bellevue, Sarpy County, Nebraska, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to convert the City of Bellevue to the regular program of flood insurance by the Federal Insurance Administration. Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain management.

1.2 Coordination

The identification of streams requiring detailed study was accomplished through joint agreement between personnel of the U. S. Army Corps of Engineers (COE), the Federal Insurance Administration, and the City of Bellevue. Information necessary for developing a community base map was obtained from the City of Bellevue.

A meeting was held on July 20, 1977 in Bellevue City Hall. The purpose of this meeting was to acquaint city officials and interested persons with the preliminary results of the Flood Insurance Study. The COE, the Federal Insurance Administration, the State of Nebraska, and the City of Bellevue were represented at the meeting.

On September 13, 1978, the results of the work performed by the Study Contractor were reviewed and accepted at the final coordination meeting, attended by personnel of the above-mentioned agencies.

1.3 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were performed by the U. S. Army Corps of Engineers for the Federal Insurance Administration,

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under Inter-Agency Agreement No. IAA-H-7-76, Project Order No. 13. This work, which was completed in December 1977, covered all significant flooding sources affecting the City of Bellevue.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the City of Bellevue, and the two mile extraterritorial zoning limits located external to the Bellevue corporate limits but over which Bellevue has jurisdiction, excluding Offutt Air Force Base. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, areas of projected development and proposed construction until December 1978.

Approximate methods of analysis were used to study those areas having low development potential and/or minimal flood hazards as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by the Federal Insurance Administration and the community.

The following streams were studied by detailed methods: the Missouri River, from the downstream extraterritorial jurisdiction limit to the Sarpy County line; Papillion Creek, from the downstream extraterritorial jurisdiction limit to the confluence of Big Papillion Creek and West Branch Papillion Creek; Big Papillion Creek, from the mouth at Papillion Creek to the upstream limit of flooding affecting the community, West Branch Papillion Creek, from the mouth at Papillion Creek to the upstream extraterritorial jurisdiction limit; Mud Creek, from the mouth at Papillion Creek to the Sarpy County line; Betz Road Ditch, from the mouth at Papillion Creek to just upstream of Harvel Road; and Squaw Creek, from the mouth at Papillion Creek to approximately 11,500 feet above the mouth. Five tributaries of Mud Creek and one tributary of Papillion Creek were studied by approximate methods.

2.2 Community Description

Bellevue is located in northeastern Sarpy County in eastern Nebraska. It is immediately south of Omaha, Nebraska. Bellevue had a 1970 population of 19,449 (Reference 1) and had an estimated 1976 population of 28,500 (Reference 2). Bellevue is situated next to Offutt Air Force Base and Strategic Air Command Headquarters. Bellevue has considerable industrial development such as prestressed concrete, fertilizer, cattle by-products, woolen goods, radio antennas, corrugated and fiber boxes, electronic equipment, office furniture, and garden tools. Recreational facilities such as public and private parks, golf courses, tennis courts, swimming pools, hiking and riding trails, fishing, and boating are available. Financial and

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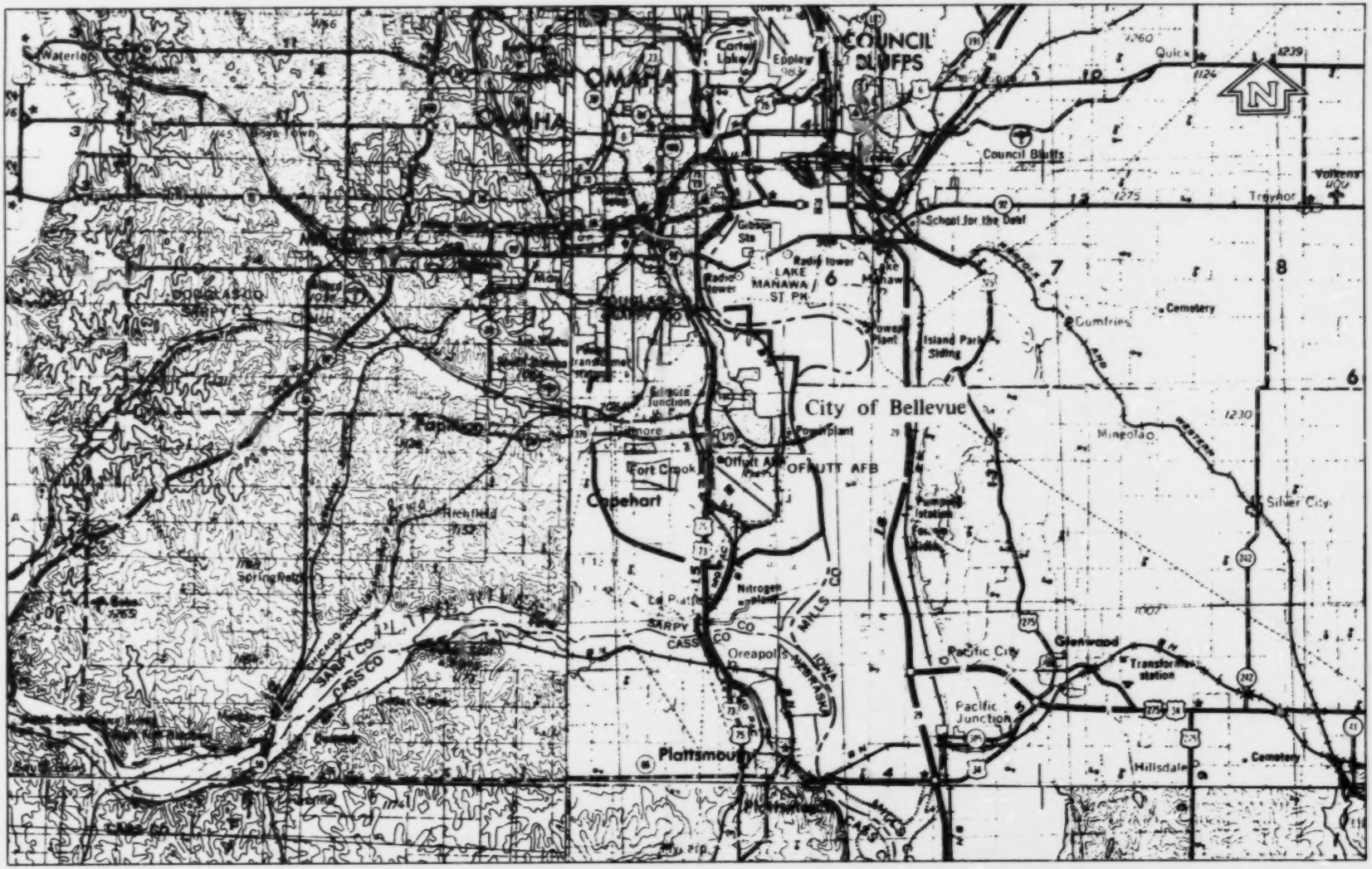

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

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medical facilities are readily available. Educational facilities in Bellevue consist of elementary schools, two junior high schools, two senior high schools, a handicapped facility, and industrial training center, and a four-year college. The community is served by newspaper, radio, and television facilities, U. S. Highway 73-75, State Highways 3760 and 131, the Burlington Northern railroad, Union Pacific Railroad, and Eppley Airfield.

Bellevue is situated in the vicinity of the Missouri River, Papillion Creek, Big Papillion Creek, West Branch Papillon Creek, Mud Creek, Betz Road Ditch, and Squaw Creek. Topography in the area ranges from steep hills to rolling plains to flat valleys. The climate in the Bellevue area is characterized by cold winters and hot summers. The average annual precipitation is about 30 inches with average January and July temperatures of about 23 degrees Fahrenheit (F.) and 77 degrees F., respectively (Reference 3). Vegetation in the Bellevue area ranges from trees to agricultural crops to miscellaneous plants. The soils in the area are glacial drift, loess, clay silt, and sandy alluvium.

The Missouri River begins in southwest Montana east of the Continental Divide near Three Forks, Montana at the junction of the Jefferson, Madison, and Gallatin Rivers. From this beginning, the river flows generally east and south approximately 1,700 miles to Bellevue. Elevations in the basin range from approximately 12,000 feet in the upper basin to approximately 975 feet at Council Bluffs, Iowa. The drainage area of the Missouri River at Bellevue is approximately 322,800 square miles. The Missouri River flood plain within the limits of Bellevue is utilized primarily for agricultural and recreational activities. Some commercial and residential uses, however, are present in some areas of the flood plain.

Papillion Creek drains approximately 402 square miles of moderately to steeply sloping land in eastern Nebraska. It begins at the western edge of the Bellevue zoning jurisdiction area at the confluence of Big Papillion Creek and West Branch Papillion Creek. It follows a general southeastern direction to the Missouri River southeast of Bellevue. Elevations in the basin range between approximately 1,350 feet and 960 feet. The flood plain uses in Bellevue are primarily agricultural with small amounts of residential, commercial, and recreational uses.

Big Papillion Creek has its source in Washington County, Nebraska, southwest of Blair, Nebraska. It drains about 234 square miles of moderately to steeply sloping land in eastern Nebraska. It flows in a general southeasterly direction to its confluence with West Branch Papillion Creek. Elevations in the basin range between approximately 1,350 feet and 980 feet. The flood plain uses in Bellevue are primarily agricultural.

West Branch Papillion Creek has its source near Elkhorn, Nebraska. It drains about 138 square miles in eastern Nebraska. Elevations in the basin range

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from about 1,300 feet to about 980 feet. The basin is predominately moderately sloping land experiencing rapid urbanization. The flood plain uses in the Bellevue area are primarily agricultural.

Mud Creek begins in the southeastern portion of Omaha, Nebraska draining an area of about 10.7 square miles. Flowing in a southerly direction, it joins Papillion Creek west of the Bellevue corporate limits. Land use in the basin is primarily residential, commercial, and industrial. Basin elevations range from about 1,250 feet in the upper basin to about 980 feet in the Papillion Creek flood plain.

Betz Road Ditch begins in the northern portion of Bellevue flowing in a general southwesterly direction to Papillion Creek just west of the Bellevue corporate limits. The drainage area of Betz Road Ditch is approximately 1.8 square miles. The basin is almost entirely urbanized and consists predominantly of residential development. Elevations in the basin range from about 1,220 feet to about 980 feet.

Squaw Creek, located about two miles west of the Bellevue corporate limits, drains an area of approximately 1.7 square miles. It begins in the extreme northwest corner of the Bellevue zoning jurisdiction area at an elevation of about 1,220 feet. The stream flows in a general southerly direction to about an elevation of 980 feet at its confluence with Papillion Creek. The basin is about 30 percent urbanized with primary uses being agricultural and residential.

Numerous city streets, highways, and rail lines cross the flood plain in Bellevue. Continuing economic development within the study area is expected and pressures leading to intensified flood plain use will undoubtedly accompany such development.

2.3 Principal Flood Problems

Bellevue lies partially within the flood plains of the Missouri River, Papillion Creek, Big Papillion Creek, West Branch Papillion Creek, Mud Creek, Betz Road Ditch, and Squaw Creek. Flooding from these streams can occur in Bellevue as a result of rapid snowmelt, heavy rainfall, or combinations thereof. Ice effects can also influence flooding, especially on the Missouri River. Flooding on this stream under open river conditions would normally be of relatively long duration with ample warning prior to the peak. Flooding due to Papillion Creek would be of much shorter duration with less warning prior to the peak. Flooding due to Mud Creek, and expecially Betz Road Ditch and Squaw Creek, could result from heavy rainfall on a relatively local basis creating short duration flooding with little warning prior to the peak. With this variation in peaking time and flood duration within Bellevue depending upon the particular stream flooding, flood fighting and evacuation procedures to be utilized in Bellevue during flood periods must also be varied.

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The Missouri River historically was a major flood problem for the Bellevue area. This, however, has changed considerably since the construction of six dams and reservoirs on the Missouri River in the Dakotas and Montana. The completion of the Missouri River Levee System - Unit R-616 tentatively scheduled for May 1979 will protect that part of Bellevue downstream from Nebraska Highway 370 (Reference 4). This flood control structure will eliminate the threat of a 500-year flood from the Missouri River for those areas of Bellevue landward of the levee system. However, due primarily to tributary inflow downsteam from the main stem dams and ice conditions, those areas of Bellevue riverward of the levee system are subject to flooding. These areas include agricultural areas, recreational areas, residential areas, and barge terminals. Historically, the largest flood of record on the Missouri River at Bellevue occurred on April 16, 1952, having a discharge of 396,000 cubic feet per second (cfs).

Flood records on Papillion Creek and Big Papillion Creek are available essentially only from 1929 to the present. Of this record, the data prior to the establishment of the Fort Crook gaging station near Capehart Road by the COE in 1946 is, at best, fragmentary. Flooding prior to 1929 has undoubtedly occurred but no records are available. From 1929 to the present, flooding occurred in 1929, 1936, 1941, 1943, 1948, 1950, 1959, 1964, and 1965. The largest flood of record at the Fort Crook stream gage occurred on June 17, 1964, having a discharge of 32,300 cfs. This flood had an approximate recurrence interval of 10 years.

Flood records on West Branch Papillion Creek are limited in scope and are available for only recent years. Floods occurring since records have been kept occurred in 1948, 1950, 1959, 1964, and 1965. Like Papillion Creek and Big Papillion Creek, the largest flood of record on West Branch Papillion Creek occurred in June 1964, having an approximate discharge of 40,800 cfs at the COE gaging station located about seven miles upstream from the mouth at Giles road. The approximate recurrence interval of this flood is slightly under 100 years.

Flooding along Mud Creek occurs relatively frequently. The most recent floods were in 1967 and 1971 as a result of heavy rainfall. Of these two floods, the 1967 flood was the largest, having an approximate recurrence interval of 25 years. Betz Road Ditch, within the past 10 years, has experienced flooding in 1967 and 1971. Due to the close proximity of Betz Road Ditch to Mud Creek, the same intense rainfall storm produced floods on both streams. The 1967 flood was the largest flood causing the loss of one life. No estimate of discharge was made.

Floods have undoubtedly occurred on Squaw Creek. However, due probably to the lack of development within the flood plain, little data is available documenting past floods.

Figures 2 through 8 show photographs of flooding from the Missouri River and Papillion Creek.

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FIGURE 2. Aerial Photograph showing Missouri River flooding in the Bellevue area, April 15, 1952.

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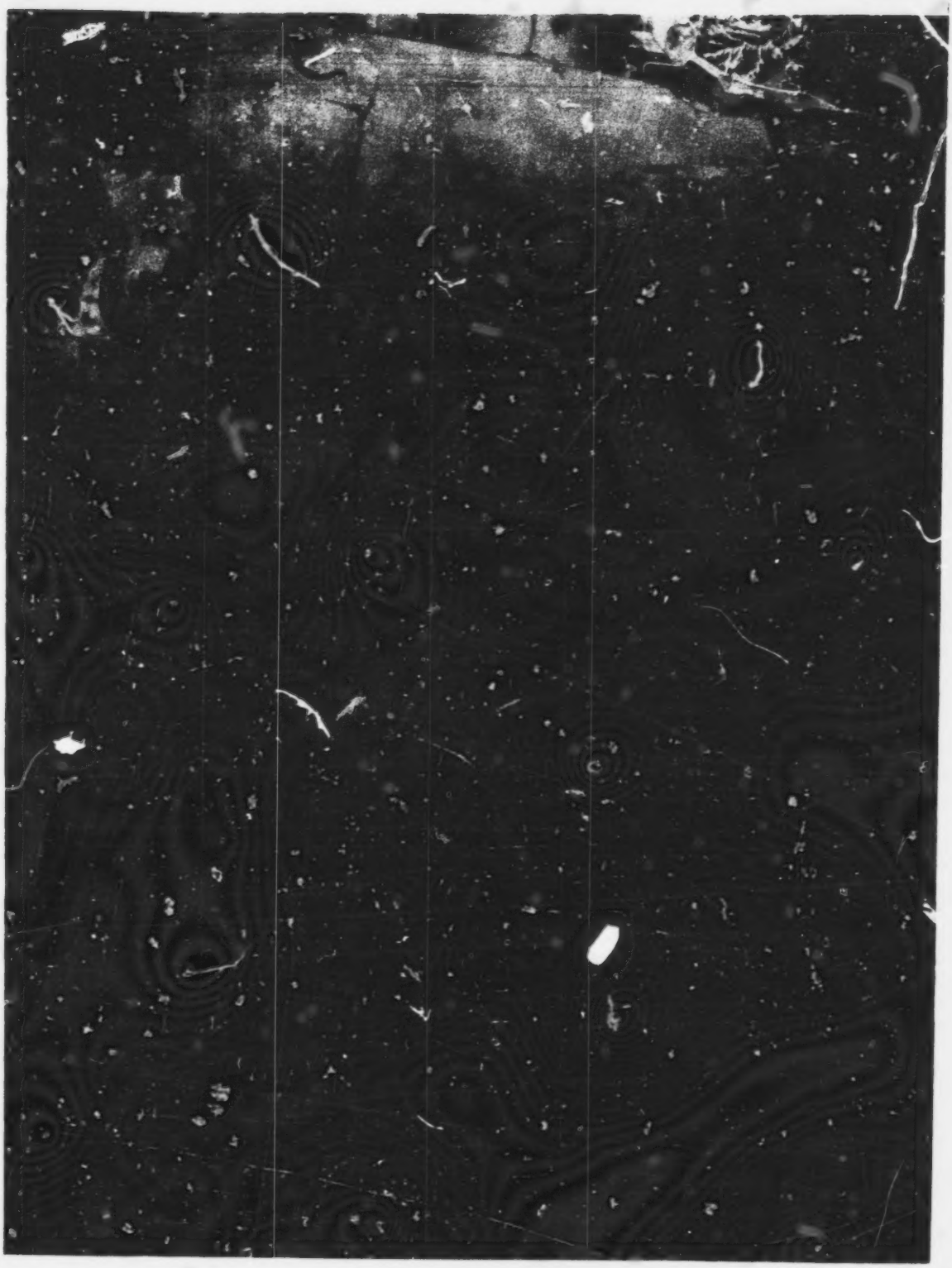

FIGURE 3. Aerial Photograph showing Missouri River Flooding in the Bellevue Area, April 15, 1952. (Note that the north of Figure 3 blends with the bottom of Figure 2.)

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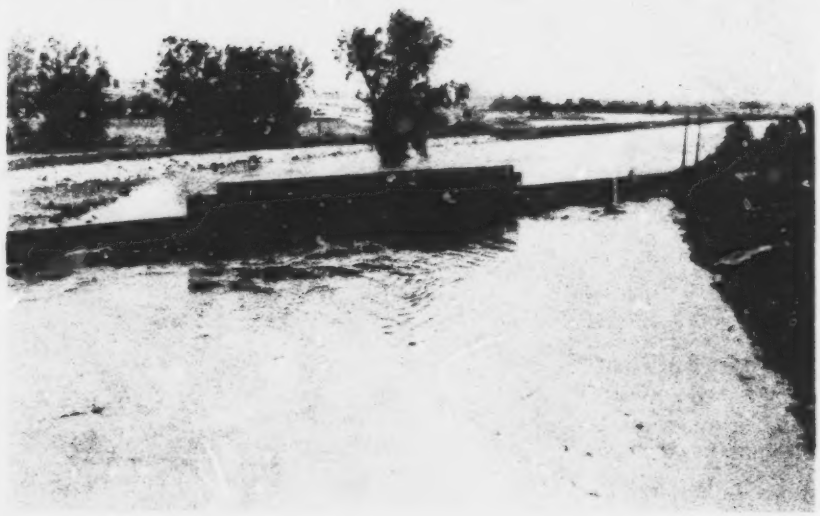

FIGURE 4. Looking downstream from the U. S. Highway 73-75 bridge over Papillion Creek, May 26, 1964.

FIGURE 5. Looking southeast across Papillion Creek flood plain from 36th Street, May 26, 1964.

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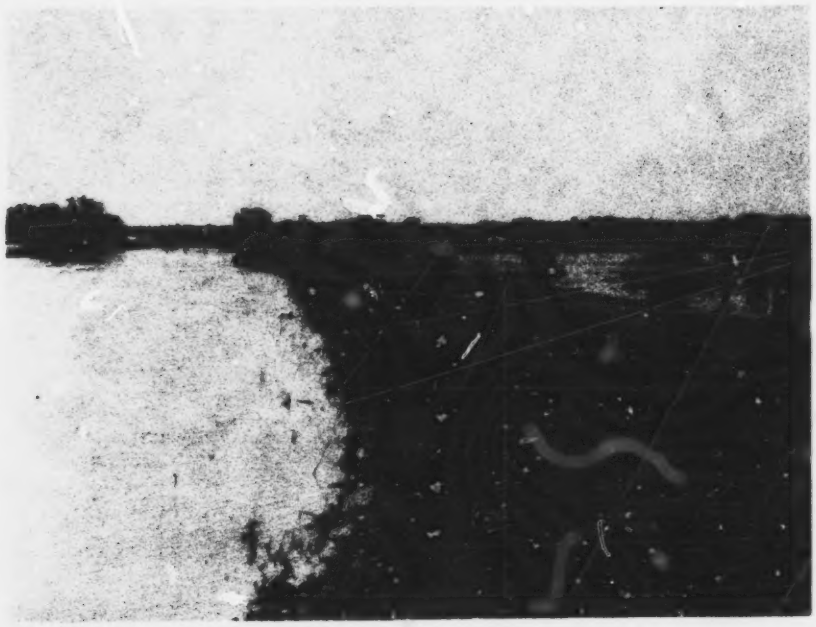

FIGURE 6. Looking upstream from Nebraska Highway 370 bridge over Papillion Creek, May 26, 1964.

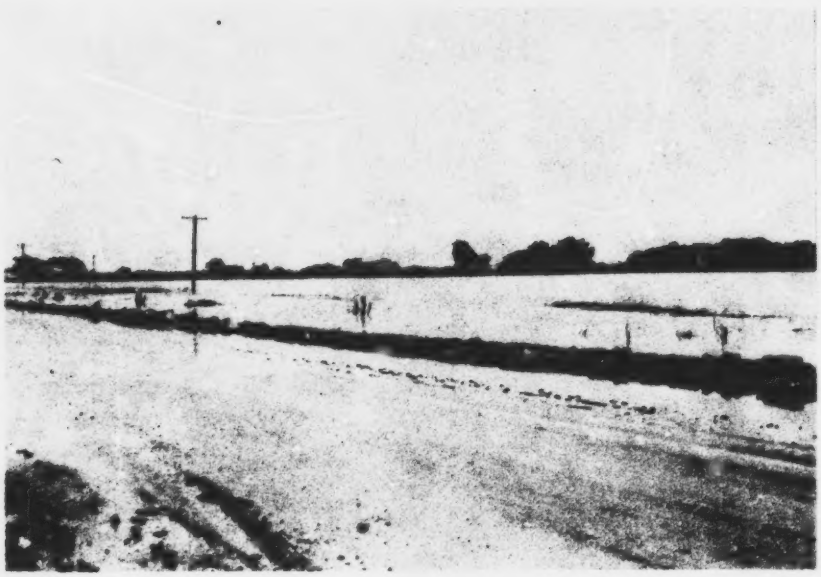

FIGURE 7. Looking north-northwest across Papillion Creek flood plain from Capehart Road west of Papillion Creek bridge, May 26, 1964.

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FIGURE 8. Looking east across the Big Papillion Creek flood plain in the vicinity of Cornhusker Road, June 18, 1964.

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2.4 Flood Protection Measures

Several dams and reservoirs are located in the Missouri River basin upstream from Bellevue. Of these dams and reservoirs, six located on the main stem of the Missouri River provide essentially all of the flood peak discharge reduction at Bellevue from the Missouri River. Data on these dams are provided in the following table.

Missouri River Main Stem Dams

Dams	Location	Year Operational
Fort Peck	Fort Peck, Montana	1940
Garrison	Riverdale, North Dakota	1955
Oahe	Pierre, South Dakota	1962
Big Bend	Fort Thompson, South Dakota	1964
Fort Randall	Pickstown, South Dakota	1953
Gavins Point	Yankton, South Dakota	1955

The Missouri River also has bank stabilization works and private levee systems located in the Bellevue area. The COE is in the early phases of constructing the Missouri River Levee System - Unit R-616 along the Missouri River from State Highway 370 downstream to Papillion Creek, river mile 601.2 to river mile 596.5 (Reference 4). Although this levee is not scheduled for completion until May 1979, the flood control aspects of this levee unit are tentatively scheduled for completion in October 1978. This levee will provide that portion of Bellevue downstream from State Highway 370 and landward of the levee with protection from Missouri River floods in excess of the 500-year flood. Since the levee system had not been completed at the time the initial work was performed, their flood protection aspects were not considered in this study.

A channel and levee flood control project has been constructed on Papillion Creek from the confluence with the Missouri River upstream to Capehart Road. This project was part of the Missouri River Levee System-Unit R-613 and was designed to provide protection from Missouri River floodwaters (Reference 5).

The Papio Natural Resources District has had a continuing program since 1968 to construct channel and levee improvements along Papillion Creek and Big Papillion Creek. These improvements are complete from Capehart Road upstream through the Bellevue jurisdictional area except for tie-back levees along Mud Creek and a short portion on the right bank upstream from the West Branch Papillion Creek confluence. These improvements provide, in general, protection against the 10-year flood.

Channel straightening has occurred on Papillion Creek, Big Papillion Creek, and West Branch Papillion Creek. This activity was performed by local interests. Channel straightening has also occurred on portions of Mud Creek,

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Betz Road Ditch, and Squaw Creek. This work also was accomplished originally by local interests. Tie-back levees have been constructed along the downstream portions of Mud Creek, Betz Road Ditch, and Squaw Creek. This work has been accomplished by local interests along Mud Creek and by the Papio Natural Resources District along Betz Road Ditch and Squaw Creek.

The COE has constructed two dams and reservoirs on tributaries of Papillion Creek which impound the 100-year flow (References 6 and 7). These dams are located about 15 miles upstream from the Bellevue area.

3.0 ENGINEERING METHODS

For flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Floods having recurrence intervals of 10-, 50-, 100-, and 500-years have been selected as having special significance for flood plain management and for flood insurance premium rates. The analyses reported here reflect current conditions in the watersheds of the streams.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each stream studied in detail in the community.

The discharge-probability relationships for the Missouri River at Omaha are based upon the Missouri River Agricultural Levee Restudy Program - Hydrology Report prepared by the COE (Reference 8). Eight gaging stations on the main stem of the Missouri River, one of them located just downstream from the Interstate Highway 480 bridge in Omaha, were the principle sources of data for defining these relationships. Stage records from the years 1898 to 1929 and stage-discharge records from the years 1929 to 1960 were used in the study. Stage values which were available for each of the gaging stations prior to 1929 were converted to discharge values by appropriate rating curves. The study of main stem reservoir effects on daily discharge hydrographs was limited to the period subsequent to 1930 when extensive gaging of tributary streams began. Eleven representative hydrographs were selected for each of the eight main stem gaging stations. The representative hydrographs used for the Omaha station were from the years 1932, 1939, 1941, 1942, 1948, 1950, 1951, 1954, 1956, 1958, and 1960. To develop a frequency-discharge relationship, the reservoir-modified annual flood peaks of the 11 representative hydrograph years were plotted in descending order. Eye-fit curves were drawn using the plotted points as guides, giving appropriate consideration to the consistency of the reservoir effects.

The discharge-probability relationships for Papillion Creek, for Big Papillion Creek, and for West Branch Papillion Creek were based upon stream gaging

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records at the Fort Crook gaging station on Papillion Creek and at the Irvington gaging station on Little Papillion Creek. These gaging stations were established in 1946 (31 years of record) and in 1948 (29 years of record), respectively, by the COE. These gaging records were analyzed statistically utilizing methods in Statistical Methods in Hydrology (Reference 9). This analysis defined runoff characteristics of the basin, thus allowing the development of synthetic hydrographs at any point in the basin. Unit hydrographs were then developed for 46 subareas in the Papillion Creek watershed. Runoff data were applied to three subarea hydrographs. Beginning at the headwaters of the basin, hydrographs for the sub-areas were added and routed progressively downstream ultimately generating hydrographs at desired locations in the Bellevue area. This approach ensured accounting for the flood plain storage available for floodwater due to the levee system constructed by the Papio Natural Resources District. As a check on this analysis, the hydrographs of the June 1964 and September 1965 floods were successfully reconstituted. The discharge decreases for Papillion and Big Papillion Creeks are due to the storage of floodwaters behind the levees with some discharge overtopping these levees.

The discharge-probability relationships for Mud Creek and for Squaw Creek were developed using the Environmental Protection Agency's Stormwater Management Model (Reference 10). The Mud Creek and Squaw Creek basins were divided into 57 and 21 subbasins, respectively. The rainfall data utilized was derived from the U. S. Weather Bureau Technical Paper No. 40 (Reference 11). A soil infiltration rate of 0.3 inch per hour was utilized throughout the basin.

The discharge-probability relationships for Betz Road Ditch were derived by the use of the rational formula. A "c" value of 0.45 was selected for the 100-year discharge. This value was adjusted depending upon the event recurrence interval. Allowances were made for the storage of floodwaters upstream from street crossings and other barriers that impede flow. A hydrograph was developed upstream from State Highway 370. This hydrograph was then routed through the highway conduit utilizing reservoir routing techniques.

The hydrologic analysis conducted on the five tributary streams of Mud Creek studied by approximate methods consisted of utilizing data developed by the hydrologic analysis on Mud Creek. The Environmental Protection Agency's Stormwater Management Model developed discharge data for those streams tributary to Mud Creek as part of the Mud Creek analysis (Reference 10).

A regional analysis was conducted to determine an approximate 100-year discharge for that stream studied by approximate methods which is tributary to Papillion Creek. This analysis utilized data developed for hydrology determinations on similar streams in the same general area.

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each stream studied in detail in the community are shown in Table 1.

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TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
MISSOURI RIVER					
At USGS stream gage at Omaha, Nebraska	322,800	125,000	170,000	190,000	250,000
PAPILLION CREEK					
Downstream extraterritorial limits	388	34,000	36,000	40,000	43,000
Capehart Road	386	34,000	36,000	40,000	46,200
Downstream from confluence with West Branch Papillion Creek	377	34,000	42,000	49,250	70,000
BIG PAPILLION CREEK					
Upstream from confluence with West Branch Papillion Creek	239	20,000	24,000	26,000	36,000
Chicago, Rock Island and Pacific Railroad	238	20,000	24,000	26,000	36,000
Upstream extraterritorial limits	237	20,000	24,650	27,000	37,500
WEST BRANCH PAPILLION CREEK					
Mouth	138	13,800	18,000	25,700	34,000
Upstream extraterritorial limits	135	13,800	18,000	25,700	34,000

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TABLE 1 - SUMMARY OF DISCHARGES (CONTINUED)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
MUD CREEK					
Mouth	10.7	3,600	5,900	7,100	11,000
2,000 feet upstream from mouth	10.4	3,600	5,900	7,100	11,000
2,100 feet upstream from mouth	9.8	2,900	4,850	5,900	9,200
6,300 feet upstream from mouth	9.3	2,750	4,650	5,600	8,800
6,400 feet upstream from mouth	8.1	1,820	3,300	4,400	7,300
100 feet downstream from Cornhusker Drive	7.9	1,820	3,300	4,400	7,300
400 feet upstream from Kasper Street	7.0	1,320	2,550	3,300	5,600
Childs Road	6.5	1,020	1,900	2,500	4,500
Chandler Road	5.8	240	800	1,450	3,100
2,700 feet upstream from Chandler Road	5.6	0	550	1,100	2,500
BETZ ROAD DITCH					
Mouth	1.8	830	1,550	1,800	3,000
Downstream from State Highway 370	1.7	830	1,550	1,800	3,000
Upstream from State Highway 370	1.7	940	1,900	2,680	6,100
Downstream from Lloyd Street	1.2	850	1,720	2,400	5,900
Upstream from Lloyd Street	0.8	570	1,180	1,600	3,800
Downstream from Lincoln Road	0.5	490	1,000	1,370	3,000
Upstream from Lincoln Road	0.3	290	600	800	1,600

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TABLE 1 - SUMMARY OF DISCHARGES (CONTINUED)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
SQUAW CREEK					
36th Street	1.7	2,150	3,100	3,600	5,000
1,000 feet downstream from Cornhusker Drive	1.5	2,000	2,940	3,450	4,900
2,400 feet upstream from Cornhusker Drive	1.3	1,920	2,880	3,350	4,850
2,500 feet upstream from Cornhusker Drive	1.2	1,750	2,650	3,100	4,400
4,500 feet upstream from Cornhusker Drive	1.1	1,720	2,600	3,100	4,600
4,600 feet upstream from Cornhusker Drive	0.7	1,240	1,900	2,260	3,400
5,800 feet upstream from Cornhusker Drive	0.7	1,180	1,860	2,200	3,150
5,900 feet upstream from Cornhusker Drive	0.5	820	1,320	1,580	2,300
1,400 feet downstream from Chandler Road	0.4	600	920	1,080	1,510

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3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community are carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each stream studied in detail.

Cross section data for Papillion Creek, Big Papillion Creek, West Branch Papillion Creek, the Missouri River, and Squaw Creek were determined by aerial photogrammetric methods using aerial photographs taken in 1964 for Papillion Creek, Big Papillion Creek, and West Branch Papillion Creek (Reference 12); aerial photographs taken in 1973 for the Missouri River (Reference 13); and aerial photographs taken in 1976 for Squaw Creek (Reference 14). The underwater sections for the Missouri River were obtained by hydrographic surveys. Cross section data for Betz Road Ditch and Mud Creek were determined by field survey in 1971 for Betz Road Ditch and in 1975 for Mud Creek. Additional cross section data were derived from plans for U. S. Highway 73-75 and utilized in the Mud Creek analysis (Reference 15). Topographic mapping having a scale of 1:2400 and a contour interval of two feet was available on the Missouri River (Reference 16). Topographic mapping having a scale of 1:1200 and a contour interval of two feet was also available on Squaw Creek (Reference 17). Bridges on Squaw Creek were surveyed in 1977 to obtain elevation and structural geometry used in computing bridge losses. Bridge losses on the Missouri River are negligible since only pier losses affect the water-surface elevation.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are shown on the Flood Boundary and Floodway Map (Exhibit 2).

Roughness coefficients (Manning's "n") for the Missouri River, Papillion Creek, Big Papillion Creek, and West Branch Papillion Creek were assigned so the computed water-surface profiles would match previously obtained high water marks and stream gaging stations. Roughness coefficients for Betz Road Ditch, Mud Creek, and Squaw Creek were estimated by field inspection at each cross section. The following table shows the roughness coefficients for each detailed study stream.

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Manning's "n" Values

Stream	Location	"n" Value
Missouri River	Channel	0.0175-0.025
	Overbank	0.035-0.150
Papillion Creek/Big Papillion Creek	Channel	0.024
	Berm	0.035
	Overbank	0.070
West Branch Papillion Creek	Channel	0.028
	Berm	0.050
	Overbank	0.070
Mud Creek	Channel	0.017-0.040
	Overbank	0.035-0.10
Betz Road Ditch	Channel	0.015-0.050
	Overbank	0.045-0.080
Squaw Creek	Channel	0.045
	Overbank	0.060-0.10

Starting water-surface elevations for the Missouri River were based on downstream backwater computations. Starting water-surface elevations for Papillion Creek were based upon stage-discharge relationships developed for the Missouri River at the mouth of Papillion Creek. Similarly, starting water-surface elevations for Big Papillion Creek, West Branch Papillion Creek, Betz Road Ditch, Mud Creek, and Squaw Creek were based upon stage-discharge relationships developed for Papillion Creek at the mouth of each stream. Water-surface profiles for all detailed study streams except Betz Road Ditch were developed using the COE backwater computer program HEC-2 (Reference 18). Water-surface profiles for Betz Road Ditch were computed using an unpublished in-house program developed by the Omaha District COE. Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

The determination of water-surface profiles on Papillion Creek and on Big Papillion Creek was especially complicated due to the levee system constructed by the Papio Natural Resources District. This levee system which begins at Capehart Road, the upstream terminus of Missouri River Levee System-Unit R-613, consists of levees along Papillion Creek and Big Papillion Creek and tie-back levees to the bluff line along Papillion Creek and Big Papillion Creek tributaries. The capacity of this system is approximately equal to the 10-year flood. Floodwater in excess of levee capacity overtops the levees being stored in ponding areas on the flood plain due to the presence of the tie-back levee system. Water will remain in storage in these ponding areas until tie-back levee failure occurs or until water-surface elevations rise sufficiently high to allow floodwater to

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overtop the tie-back levees, then flowing downstream on the flood plain to the next tie-back levee and resultant ponding area. Since predicting levee failure is an extremely difficult task, if not impossible, the hydraulic analysis portion of this study was conducted under the premise that the levee system along Papillion Creek and Big Papillion Creek would ultimately fail, inundating the entire valley, but that the maximum water-surface elevation would result from floodwater overtopping the levee system before failure. This condition was considered to be worse since it would allow maximum water on the flood plain and yet restrict water flow on the flood plain until flood plain water-surface elevations were at an elevation which would allow overtopping of the levee system. The water-surface profiles reflect the 10-year flood entirely within the levee system. The water-surface profiles for floods in excess of the 10-year flood reflect Papillion Creek and Big Papillion Creek levee failure allowing a maximum amount of water on the flood plain but a tie-back levee system intact allowing a maximum water-surface elevation. This method of analysis accounts for some instances where the 10-year flood may be the highest in water-surface elevation of all floods analyzed. In addition, a 100-year profile has been shown and labelled "10-year flood for zone determination" in order to justify the Flood Hazard Factors for the reaches affected.

The depth for the sheet flow along Betz Road Ditch was determined from loss of discharge due to overtopping of embankments, field inspection, and available topographic maps (Reference 19).

The water-surface elevations on those streams studied by approximate methods were determined by normal-depth computations. Cross section data were derived from U. S. Geological Survey (USGS) 7.5 minute series quadrangle mapping (Reference 20).

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles (Exhibit 1) are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage state and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Insurance Administration as the base flood for purposes of flood plain management measures. The 500-

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year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using topographic mapping having a scale of 1:2400 with two-foot contour intervals (Reference 16) and USGS 7.5 minute series quadrangle maps (Reference 20) for the Missouri River; using USGS 7.5 minute series quadrangle maps (Reference 20) for Papillion Creek, Big Papillion Creek, West Branch Papillion Creek, and Mud Creek; using topographic mapping at a scale of 1:1200, with a contour interval of two feet (Reference 17) for Squaw Creek; and using topographic mapping at a scale of 1:1200, with a contour interval of two feet (Reference 19) and 7.5 minute series quadrangle maps (Reference 20) for Betz Road Ditch. Sheet flow was delineated using USGS 7.5 minute series quadrangle maps (Reference 20).

Approximate flood boundaries were delineated from USGS 7.5 minute series quadrangle maps (Reference 20).

The Missouri River Levee System-Unit R-613 was designed along Papillion Creek, from its confluence with the Missouri River upstream to Capehart Road, to provide protection from Missouri River floodwaters.

The boundaries of the 100-year and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). Small areas within the flood boundaries may lie above the flood elevations, and, therefore, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity and increases flood heights, thus increasing flood hazard in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment in order that the 100-year flood be carried without substantial increases in flood heights. As minimum standards, the Federal Insurance Administration limits such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced.

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Floodways delineated along Mud Creek and Squaw Creek were computed on the basis of equal conveyance reduction from each side of the flood plain (HEC-2, Method 4) and by specifying left and right bank encroachment stations (HEC-2, Method 1) (Reference 18). The floodway along Betz Road Ditch was computed using an unpublished in-house computer program developed by the Omaha District COE. The Missouri River floodway coincides with the location of Missouri River Levee Systems where they are constructed as well as where they are proposed. In areas where levees are not proposed, the minimum floodway width is 3,000 feet. These floodways were checked using HEC-2, Method 1 to verify nonexceedance of the 1.0-foot rise criteria. The floodway for Papillion Creek coincides with the Missouri River Levee System-Unit R-613 downstream from Capehart Road utilizing HEC-2, Method 1. Upstream from Capehart Road, HEC-2, Method 4 was used for floodway computations. The floodway upstream from Capehart Road was checked to ensure that flood plain encroachment would not decrease available floodwater storage area to the point of causing discharge increases downstream relative to pre-encroachment conditions. A similar floodway computational procedure was utilized for Big Papillion Creek and for West Branch Papillion Creek. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2).

The eastern boundary of portions of Bellevue is the approximate center of the Missouri River, where parts of the floodway form the extraterritorial limits. Because of this, regulation of the floodway will require cooperation and coordination between the City of Bellevue and the governing bodies that have jurisdiction over the floodway on the opposite side of the Missouri River (Council Bluffs, Iowa and Pottawattamie County, Iowa).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 9.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
MISSOURI RIVER							
A	3,161,875	3043	34,304	5.54	969.1	968.1	1.0
B	3,163,935	3049	34,887	5.45	969.4	968.6	0.8
C	3,165,835	3041	34,271	5.54	969.8	969.4	0.4
D	3,167,950	3009	37,966	5.01	970.3	970.0	0.3
E	3,169,795	3082	37,715	5.04	970.7	970.1	0.6
F	3,171,750	3006	36,087	5.27	970.9	970.2	0.7
G	3,173,755	3354	38,106	4.99	971.1	970.4	0.7
H	3,175,655	2756	34,316	5.54	971.4	970.6	0.8
I	3,177,715	2630	34,238	5.55	971.6	971.1	0.5
J	3,179,720	2416	29,318	6.48	971.6	971.4	0.2
K	3,181,675	2684	31,007	6.13	972.1	971.5	0.6
L	3,182,785	3287	38,888	4.89	972.5	971.7	0.8
M	3,184,845	3350	40,092	4.74	973.0	972.9	0.1
N	3,187,695	3540	40,801	4.66	973.6	973.1	0.5
O	3,214,517	4095	51,385	3.70	977.8	976.9	0.9
P	3,217,738	3240	42,301	4.50	978.3	977.5	0.8
Q	3,220,166	3450	26,820	7.10	978.3	977.5	0.8
R	3,223,018	3420	33,107	5.70	978.8	978.0	0.8

[1]FEET ABOVE MOUTH
[2]THIS WIDTH EXTENDS BEYOND EXTRATERRITORIAL LIMITS

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

FLOODWAY DATA

MISSOURI RIVER

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
PAPILLION CREEK							
A	28,930	500	6044	6.62	986.0	985.0	1.0
B	29,770	3161	46,123	0.88	986.3	985.3	1.0
C	30,680	3258	42,517	0.97	986.3	985.3	1.0
D	31,750	3696	45,571	0.92	986.4	985.4	1.0
E	33,400	2488	33,600	1.28	988.0	987.0	1.0
F	33,880	3854	48,260	0.90	988.1	987.1	1.0
G	36,300	4029	54,424	0.82	991.0	990.0	1.0
H	38,060	3702	53,465	0.86	992.0	991.0	1.0
I	39,270	3408	40,897	1.14	992.0	991.0	1.0
J	41,740	2564	35,375	1.37	992.2	991.2	1.0
K	42,790	1642	18,539	2.65	992.3	991.3	1.0
BIG PAPILLION CREEK							
L	45,100	2523[3]	11,697	2.22	992.9	992.0	0.9
M	45,430	2846[3]	12,512	2.08	993.0	992.1	0.9
N	46,000	1210	12,900	2.02	994.6	993.8	0.8
O	47,250	3366[4]	43,594	0.61	998.4	997.5	0.9
P	48,450	5150[4]	53,148	0.51	998.4	997.5	0.9
Q	49,500	5360[4]	62,945	0.44	998.4	997.5	0.9
R	50,640	5825[5]	58,680	0.49	998.5	997.6	0.9
WEST BRANCH PAPILLION CREEK							
A	1440[2]	2523[3]	10,174	2.53	992.7	991.8	0.9
B	1990[2]	2846[3]	12,110	2.12	993.0	992.1	0.9
C	2900[2]	996	6803	3.78	995.5	994.5	1.0

[1]FEET ABOVE CONFLUENCE WITH MISSOURI RIVER
[2]FEET ABOVE MOUTH
[3]COMBINED FLOODWAY WIDTH OF BIG PAPILLION CREEK AND WEST BRANCH PAPILLION CREEK
[4]THIS WIDTH EXTENDS BEYOND EXTRATERRITORIAL LIMITS
[5]THIS WIDTH IS BEYOND EXTRATERRITORIAL LIMITS

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

FLOODWAY DATA

PAPILLION CREEK - BIG PAPILLION CREEK
WEST BRANCH PAPILLION CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
MUD CREEK							
A	2588	153	1245	4.7	984.1	984.1[2]	0.0
B	3335	81	501	11.6	984.1	984.1[2]	0.0
C	3735	89	586	9.9	986.2	986.2[2]	0.0
D	4136	172	1223	4.7	989.0	989.0[2]	0.0
E	4536	197	1663	3.4	989.4	989.4[2]	0.0
F	5400	56	603	9.4	997.2	997.2	0.0
G	5960	249	1999	2.6	1000.6	999.7	0.9
H	6640	355	1898	2.6	1001.5	1000.5	1.0
I	6980	126	940	4.7	1001.9	1001.0	0.9
J	7110	77	375	11.7	1003.5	1003.5	0.0
K	8195	75	548	8.0	1010.1	1010.0	0.1
L	9695	188	652	6.4	1020.3	1020.1	0.2
M	10,295	200	1006	4.0	1022.0	1021.1	0.9
N	10,630	290	1556	2.6	1022.4	1021.7	0.7
O	11,305	305	539	4.6	1022.7	1021.8	0.9
P	11,485	215	330	7.4	1023.8	1023.3	0.5
Q	12,000	268	1044	3.5	1025.5	1024.8	0.7
R	12,400	230	849	4.2	1026.7	1026.6	0.1
S	12,580	152	430	8.2	1027.5	1026.9	0.6
T	13,450	200	1151	2.9	1032.4	1031.5	0.9
U	13,990	198	884	3.7	1032.7	1031.7	1.0
V	14,590	163	641	4.8	1033.3	1032.7	0.6
W	15,200	145	756	3.8	1034.3	1034.0	0.3
X	15,900	106	349	4.6	1037.5	1037.5	0.0
Y	16,460	101	189	7.9	1038.1	1037.6	0.5
Z	17,090	131	376	6.4	1040.7	1040.7	0.0
AA	18,100	136	614	3.3	1046.3	1045.5	0.8
AB	18,510	122	491	3.8	1046.9	1046.2	0.7

[1]FEET ABOVE MOUTH
[2]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM PAPILLION CREEK

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

FLOODWAY DATA

MUD CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
MUD CREEK							
AC	19,160	100	246	6.7	1048.7	1048.5	0.2
AD	20,290	204	896	1.6	1054.4	1054.2	0.2
AE	20,800	293	1099	1.2	1054.6	1054.4	0.2
AF	21,260	222	586	2.1	1054.8	1054.6	0.2
AG	21,760	60	171	6.8	1056.1	1055.9	0.2
AH	22,300	60	159	6.9	1059.3	1058.7	0.6
AI	22,470	60	194	5.7	1060.2	1059.2	1.0
BETZ ROAD DITCH							
A	1845	40	220	8.2	981.5	981.5[2]	0.0
B	2070	40	244	7.4	983.8	983.8[2]	0.0
C	2640	40	225	8.1	987.5	987.5[2]	0.0
D	3140	40	578	3.1	989.6	989.6	0.0
E	3370	68	491	3.7	1000.2	999.2	1.0
F	3900	69	552	3.3	1000.7	1000.0	0.7
G	4410	48	317	5.7	1000.9	1000.2	0.7
H	4740	168	1969	1.3	1017.9	1016.9	1.0
I	5050	147	1559	1.7	1017.9	1017.2	0.7
J	5530	129	870	3.0	1018.0	1017.2	0.8
K	5660	135	547	4.8	1020.5	1019.5	1.0
L	6110	28	242	10.7	1021.5	1021.4	0.1
M	6350	20	218	11.9	1023.3	1022.7	0.6
N	6860	25	284	9.2	1027.8	1027.1	0.7
O	7170	30	301	8.6	1029.3	1028.6	0.7
P	7350	91	405	6.4	1034.4	1033.4	1.0
Q	7990	154	412	6.3	1038.7	1038.4	0.3
R	8720	125	158	6.3	1050.4	1049.7	0.7

[1]FEET ABOVE MOUTH
[2]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM PAPILLION CREEK

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TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

FLOODWAY DATA

MUD CREEK - BETZ ROAD DITCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
BETZ ROAD DITCH							
S	9300	42	383	3.9	1057.2	1056.8	0.4
T	9770	50	317	4.7	1057.6	1057.0	0.6
U	9930	60	381	3.8	1058.5	1057.5	1.0
V	10,520	75	200	7.1	1060.6	1060.1	0.5
W	11,052	105	180	3.9	1069.6	1069.2	0.4
X	11,370	75	469	2.9	1074.3	1073.4	0.9
Y	11,790	100	443	1.8	1078.4	1077.4	1.0

[1]FEET ABOVE MOUTH

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

FLOODWAY DATA

BETZ ROAD DITCH

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
SQUAW CREEK							
A	1540	140	506	7.1	987.8	987.9[2]	0.0
B	1920	121	699	5.2	989.9	989.9[2]	0.0
C	2095	181	930	3.9	991.4	991.4[2]	0.0
D	2375	150	1278	2.8	994.2	993.6[2]	0.6
E	2980	95	664	5.3	994.6	993.9[2]	0.7
F	3422	100	547	6.4	995.9	994.9[2]	1.0
G	3890	75	432	8.0	998.1	997.1	1.0
H	4440	53	667	5.1	1000.6	999.9	0.7
I	4955	44	275	1.9	1001.2	1000.9	0.3
J	5480	150	1822	2.0	1019.6	1018.6	1.0
K	5941	205	1707	2.0	1019.7	1018.7	1.0
L	6390	228	1887	1.8	1019.8	1018.8	1.0
M	6895	93	786	4.3	1019.9	1018.8	1.0
N	7451	63	563	5.9	1020.5	1018.9	0.8
O	7890	70	452	6.9	1021.8	1019.7	1.0
P	8300	55	385	8.0	1023.8	1023.0	0.8
Q	8785	75	623	5.0	1026.2	1025.5	0.7
R	9245	90	819	3.8	[illegible]7.5	1026.6	0.9
S	9875	110	826	3.4	[illegible]8.1	1027.3	0.8
T	10,515	45	297	7.5	1034.8	1034.8	0.0
U	10,680	79	558	3.7	1036.5	1036.5	0.0
V	11,515	55	294	5.2	1037.3	1037.2	0.1

[1]FEET ABOVE MOUTH
[2]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM BIG PAPILLION CREEK

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

FLOODWAY DATA

SQUAW CREEK

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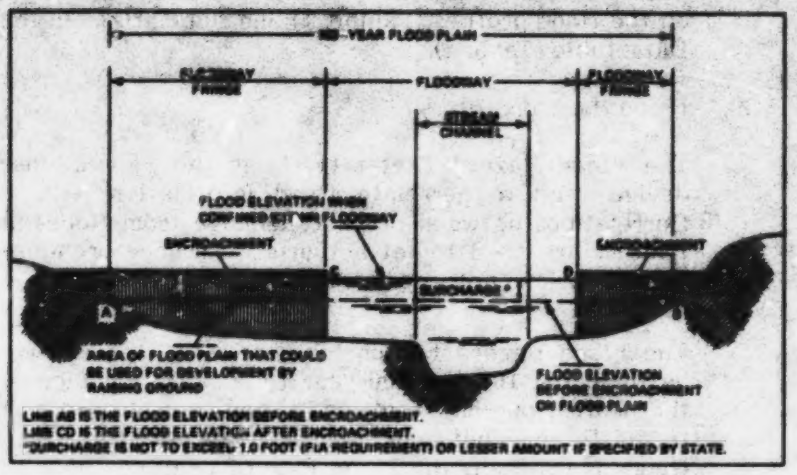
100-YEAR FLOOD PLAIN
FLOODWAY
STREAM CHANNEL
ENCROACHMENT
ENCROACHMENT
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.

FIGURE 9. Floodway Schematic

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the Federal Insurance Administration has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source affecting the City of Bellevue.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet

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The locations of the reaches determined for the City of Bellevue are shown on the flood profiles (Exhibit 1) and summarized in the Flood Insurance Zone Data Table (Table 3).

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is the Federal Insurance Administration device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their Flood Hazard Factors are used to set actuarial insurance premium rate tables based on Flood Hazard Factors from 005 to 200.

The Flood Hazard Factor for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest one-half foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the Flood Hazard Factor is 005; if the difference is 1.4 feet, the Flood Hazard Factor is 015; if the difference is 5.0 feet, the Flood Hazard Factor is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the Flood Hazard Factor is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective Flood Hazard Factors, the entire area of the City of Bellevue was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or Flood Hazard Factors determined.
Zone A0:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown; but no Flood Hazard Factors are determined.
Zones A4-A10, A14, A 15, A21:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to Flood Hazard Factor.

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Zone B:	Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, Flood Hazard Factors, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Bellevue is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the Federal Insurance Administration.

6.0 OTHER STUDIES

The COE in February 1967 published Review Report for Papillion Creek and Tributaries, Nebraska (Reference 21). This publication concerned the extent and magnitude of the flood problem in the Papillion Creek basin and proposed a series of dams and reservoirs to be located in the basin. Information contained in that COE study essentially is compatible with that contained in this Flood Insurance Study; the main difference being updated hydrology reflecting more years of stream record.

The COE published in November 1967 Flood Plain Information, Papillion, Big Papillion and West Papillion Creeks, Volume I, Omaha Metropolitan Region, Nebraska (Reference 22). This report defined the flood plain in the lower Papillion Creek basin. Information contained in this report is compatible with that contained in this study. Differences which do exist are due to updated computation procedures.

In June 1975, the COE published Flood Control - Flood Management - Volume V, Water Resources Management Alternatives for the Omaha-Council Bluffs Area as part of the COE Urban Studies Program (Reference 23). The purpose of the report

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[3] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
MISSOURI RIVER							
REACH 1	0010, 0020	–4.1	–1.4	2.9	040	A8	VARIES–SEE MAP
REACH 2	0005, 0010	–5.2	–1.4	3.4	050	A10	VARIES–SEE MAP
PAPILLION CREEK							
REACH 1	0015, 0020	–1.9	–0.8	0.6	020	A4	VARIES–SEE MAP
REACH 2	0015	–4.6	–2.5	1.0	045	A9	VARIES–SEE MAP
REACH 3	0005, 0015	–6.9	–3.2	0.6	070	A14	VARIES–SEE MAP
BIG PAPILLION CREEK							
REACH 1	0005	–4.0	–0.6	1.5	040	A8	VARIES–SEE MAP
REACH 2	0005	–7.2	–0.7	3.1	070	A14	VARIES–SEE MAP
WEST BRANCH PAPILLION CREEK							
REACH 1	0005	–3.8	–0.4	1.2	040	A8	VARIES–SEE MAP
REACH 2	0005	–2.9	–1.5	1.1	030	A6	VARIES–SEE MAP
MUD CREEK							
REACH 1	0005	–4.0	–1.5	2.1	040	A8	VARIES–SEE MAP
REACH 2	0005	–2.0	–0.7	1.3	020	A4	VARIES–SEE MAP

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

FLOOD INSURANCE ZONE DATA

MISSOURI RIVER - PAPILLION CREEK - BIG PAPILLION CREEK - WEST BRANCH PAPILLION CREEK - MUD CREEK

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
BETZ ROAD DITCH							
REACH 1	0005	-6.8	-4.0	0.0	070	A14	VARIES–SEE MAP
REACH 2	0005	-3.9	-1.0	1.8	040	A8	VARIES–SEE MAP
REACH 3	0005	-11.1	-4.5	4.5	110	A21	VARIES–SEE MAP
REACH 4	0005	-3.6	-0.9	2.8	035	A7	VARIES–SEE MAP
REACH 5	0005,0010	-1.8	-0.7	1.4	020	A4	VARIES–SEE MAP
SQUAW CREEK							
REACH 1	0005	-2.3	-1.8	1.4	025	A5	VARIES–SEE MAP
REACH 2	0005	-7.5	-4.1	10.2	075	A15	VARIES–SEE MAP
REACH 3	0005	-2.8	-1.3	6.5	030	A6	VARIES–SEE MAP

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

FLOOD INSURANCE ZONE DATA

BETZ ROAD DITCH - SQUAW CREEK

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was to present the results of studies made regarding existing and potential future flood problems in the Metropolitan Omaha, Nebraska-Council Bluffs, Iowa study area. The information presented in the report is intended to assist other agencies in making future planning decisions. Flood outlines in that report do not match exactly those shown in this Flood Insurance Study since an approximate analysis was used to determine flood outlines for the Urban Studies Report.

The COE completed the Council Bluffs, Iowa Flood Insurance Study in June 1978 (Reference 24). Information in that study pertinent to the Bellevue Flood Insurance Study is the same as that contained in this study. The construction of a levee along the Missouri River south of State Highway 370 is reflected in the Missouri River profiles contained in this Flood Insurance Study. The Missouri River profiles in this study equal or exceed by less than 0.5 foot those shown in the Council Bluffs Flood Insurance Study.

In October 1977, the COE published Special Flood Hazard Information Report, Missouri River, Gavins Point Dam to Rulo, Nebraska, Volume I, River Mile 659.4-581.3 (Reference 25). The information shown on this Flood Insurance Study is compatible with that shown in the Special Flood Hazard Report.

The COE is currently conducting the technical aspects of the Sarpy County, Nebraska Flood Insurance Study (Reference 26). Information in that study is compatible with that contained in this study.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic and other pertinent data used in this study can be obtained by contacting the office of the Federal Insurance Administration, Regional Director, 911 Walnut Street, Kansas City, Missouri 64106.

8.0 REFERENCES AND BIBLIOGRAPHY

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5. ———————, Missouri River, Sioux City, Iowa to the Mouth, Agricultural Levees, Design Memorandum No. R-613-1, April 1966.

6. ———————, Papillion Creek and Tributaries, Nebraska, Design Memorandum No. NPC-15, Site 11, March 1972.

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10. Environmental Protection Agency, Stormwater Management Model, Computer Program, 1971.

11. U. S. Department of Commerce, Weather Bureau, Technical Paper No. 40, Rainfall Frequency Atlas of the United States: For Durations from 1 to 100 Years, D. H. Herschfield, U. S. Government Printing Office, May 1961.

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13. Hoskins, Western & Sonderegger, Lincoln, Nebraska, Aerial Photographs, Scale 1:1200, Contour Interval two feet: Bellevue, Nebraska, 1976.

14. Gollenon & Schemmer & Associates, Omaha, Nebraska, Aerial Photographs, Scale 1:2400, Contour Interval two feet: Missouri River Mile 609 - Upstream, Bellevue, Nebraska, 1973; Hoskins, Western & Sonderegger, Lincoln, Nebraska, Aerial Photographs, Scale 1:2400, Contour Interval two feet: Missouri River Mile 609 - Downstream, Bellevue, Nebraska, 1973.

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18. ———————, Hydrologic Engineering Center, HEC-2 Water-Surface Profiles, Computer Program, Davis, California, February 1972.

19. Great Plains Aerial Survey, Topographic Mapping, Scale 1:1200, Contour Interval two feet: Betz Road Ditch, Bellevue, Nebraska, 1974.

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20. U. S. Geological Survey, 7.5 Minute Series Quadrangle Maps, Scale 1:24000, Contour Interval 10 feet: Council Bluffs South, Iowa-Nebraska, 1956, (Photorevised) 1964; Pacific Junction, Iowa-Nebraska, 1956, (Photorevised) 1969; Omaha South, Nebraska-Iowa, 1956, (Photorevised) 1969; Plattsmouth, Nebraska, 1956, (Photorevised) 1969.

21. U. S. Army Corps of Engineers, Omaha District, Review Report for Papillion Creek and Tributaries, Nebraska, February 1967.

22. ———————, Flood Plain Information, Papillion, Big Papillion, and West Papillion Creeks, Volume I, Omaha Metropolitan Region, Nebraska, November 1967.

23. ———————, Flood Control-Flood Management, Volume V, Water Resources Management Alternatives for the Omaha-Council Bluffs Area, June 1975.

24. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, City of Council Bluffs, Iowa, June 1978.

25. U. S. Army Corps of Engineers, Omaha District, Special Flood Hazard Information Report, Missouri River, Gavins Point Dam to Rulo, Nebraska, Volume I, River Mile 659.4-481.3, October 1977.

26. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Sarpy County, Nebraska, (in progress).

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9.0 REVISIONS DESCRIPTION

This section has been added to provide information regarding significant revisions made since the original Flood Insurance Study was printed. Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To assure that any user is aware of all revisions, it is advisable to contact the community repository of flood hazard data located at 210 West Mission Street, Bellevue, Nebraska 68005.

9.1 First Revision (Revised June 4, 1987)

a. Acknowledgments

The data for this Revisions Description were obtained from the U.S. Army Corps of Engineers (COE), Omaha District. The Federal Emergency Management Agency (FEMA) reviewed and accepted these data for purposes of this revision.

b. Scope

The COE has constructed Levee R-616 along the west bank of the Missouri River from the confluence of Papillion Creek upstream to Mission Avenue. The COE has certified that Levee R-616 has sufficient stability and freeboard to protect properties along the landward side from a 100-year flood.

c. Hydrologic and Hydraulic Analyses

The COE has performed interior drainage calculations and has determined 100-year ponding elevations for areas along the landward side of Levee R-616. The ponding areas were delineated using topographic maps compiled by the COE (Reference 1). The ponding areas were designated Zone AH with 100-year elevations identified. The remaining areas protected from a 100-year flood by Levee R-616 were removed from the Special Flood Hazard Area designation and redesignated Zone B.

d. Floodways

The floodway along the Missouri River was widened to include Levee R-616. No new floodway calculations were performed for the Missouri River or any other waterway within the City of Bellevue.

e. Other Studies

The Flood Insurance Study for the Unincorporated Areas of Sarpy County (Reference 2) was revised in conjunction with this study. These studies match exactly.

f. Location of Data

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological

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Hazards Division, FEMA, Old Federal Office Building, Room 300, 911 Walnut Street, Kansas City, Missouri 64106.

g. References and Bibliography

1. U.S. Army Corps of Engineers, Topographic Mapping, Scale 1:4800, Contour Interval 4 feet: Missouri River, Gavins Point Dam to Rulo Nebraska, River Mile 595.5 to 601.9, April 1973.

2. Federal Emergency Management Agency, Federal Insurance Association, Flood Insurance Study, Sarpy County, Unincorporated Areas, Nebraska, January 1981, revised June 4, 1987.

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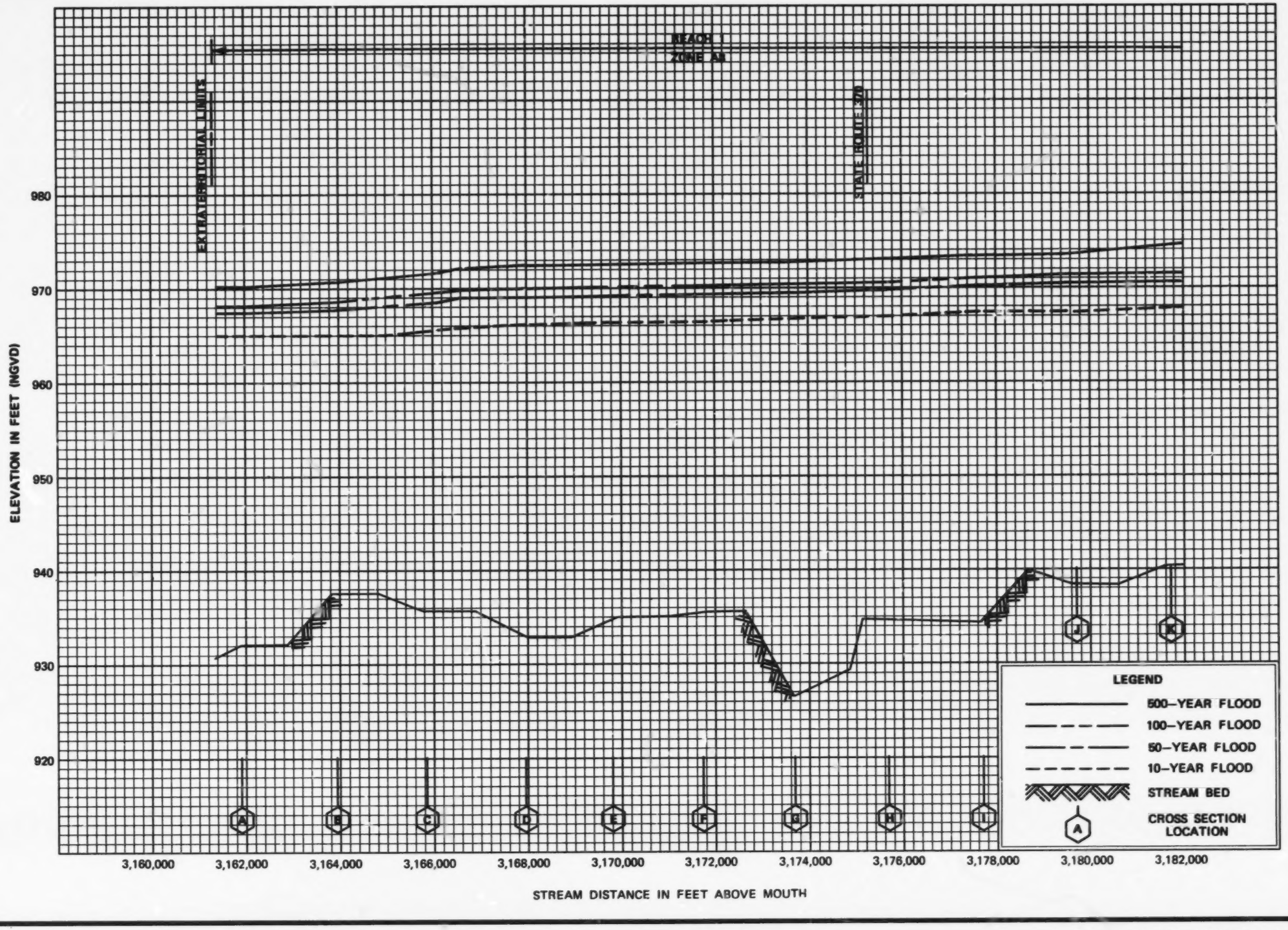

FLOOD PROFILES

MISSOURI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

01P

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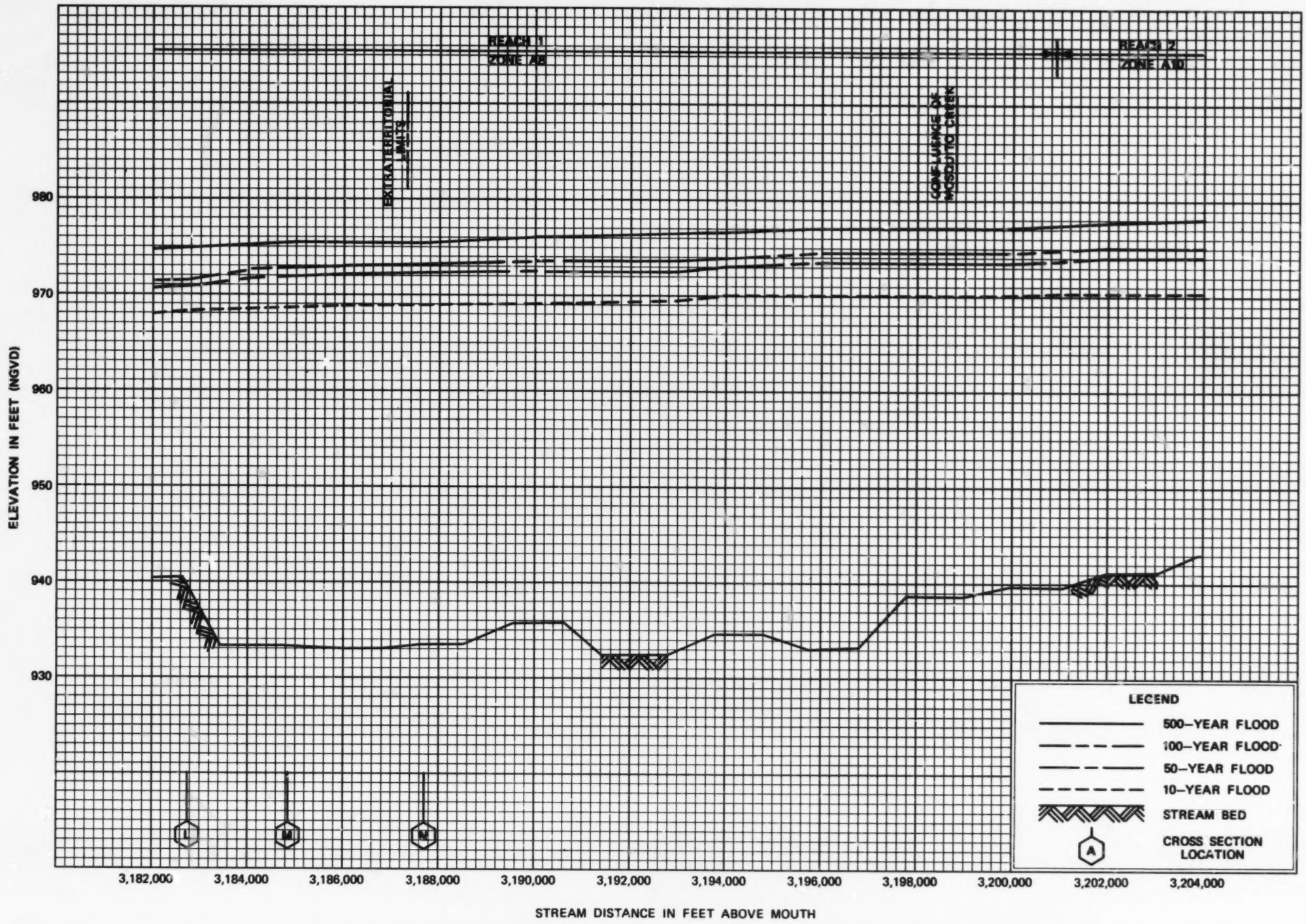

FLOOD PROFILES

MISSOURI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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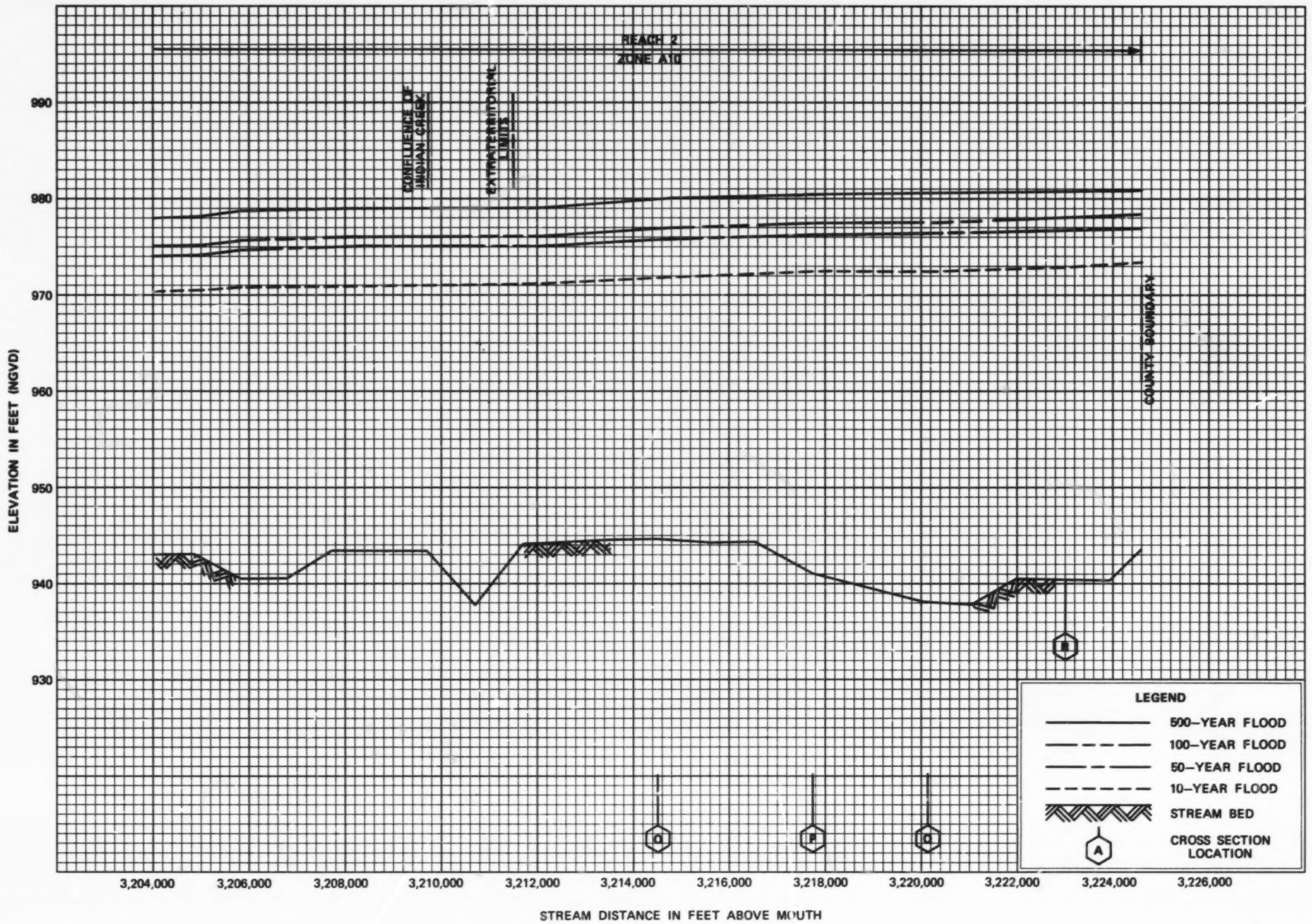

FLOOD PROFILES

MISSOURI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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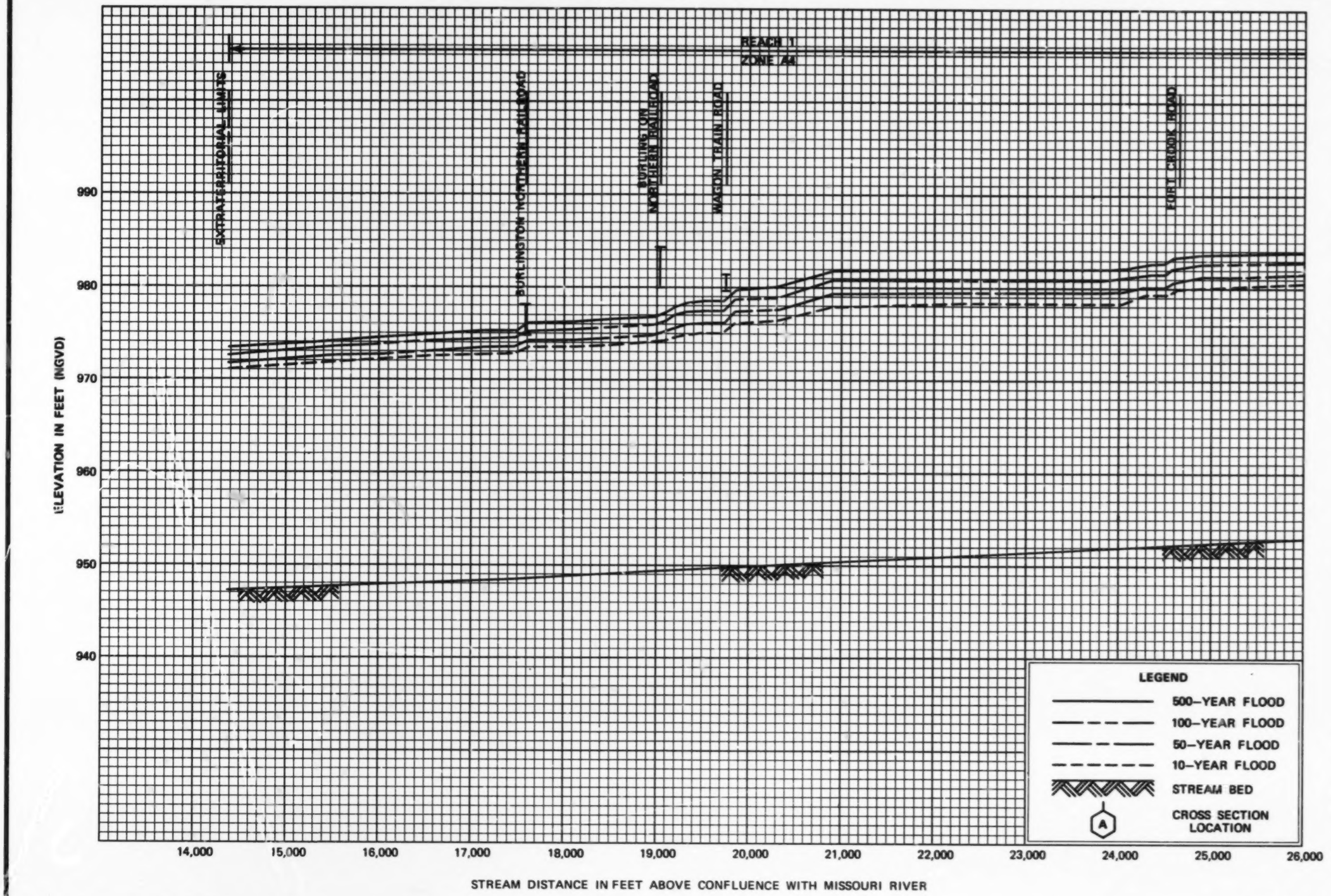

FLOOD PROFILES

PAPILLION CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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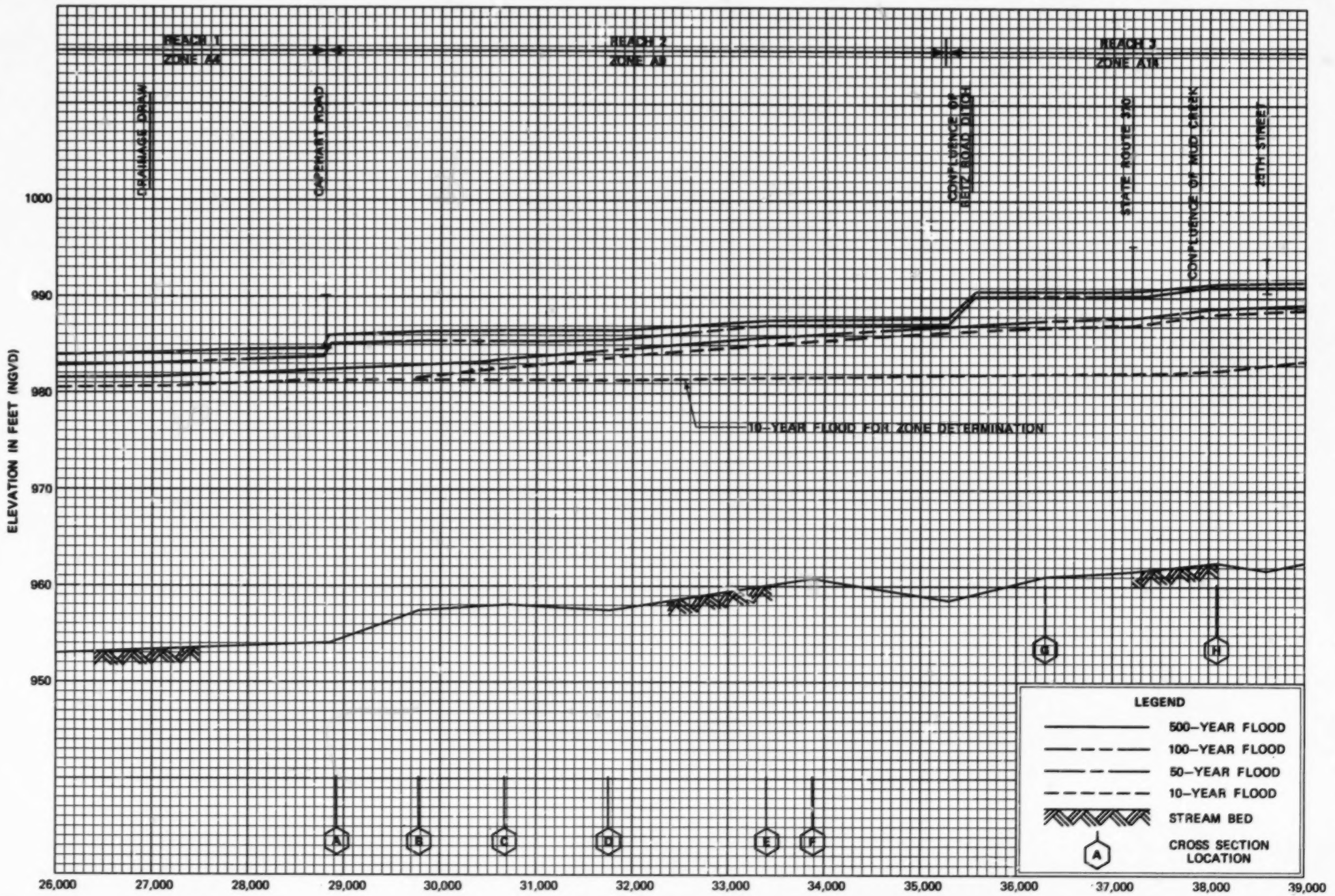

FLOOD PROFILES

PAPILLION CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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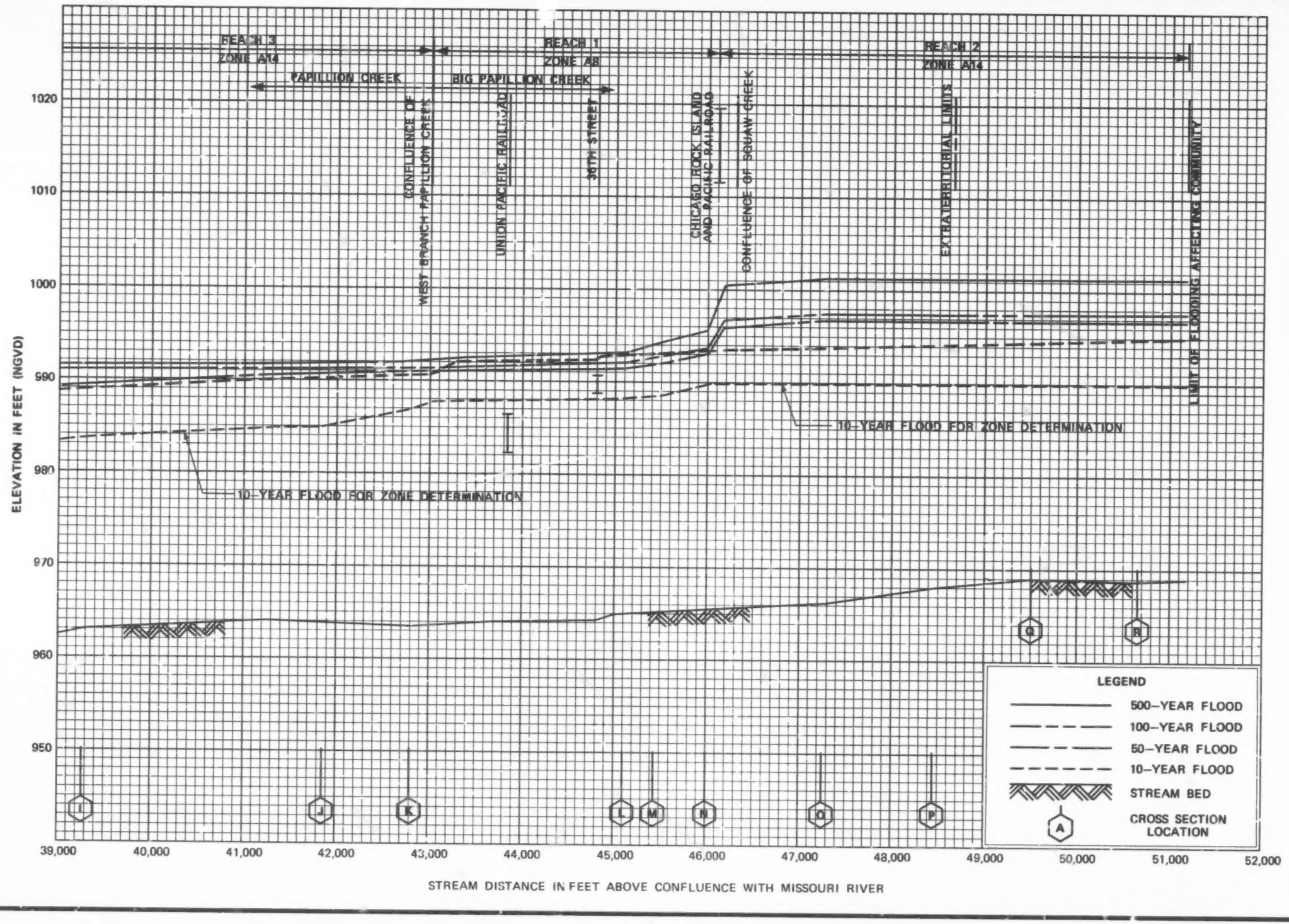

FLOOD PROFILES

PAPILLION CREEK - BIG PAPILLION CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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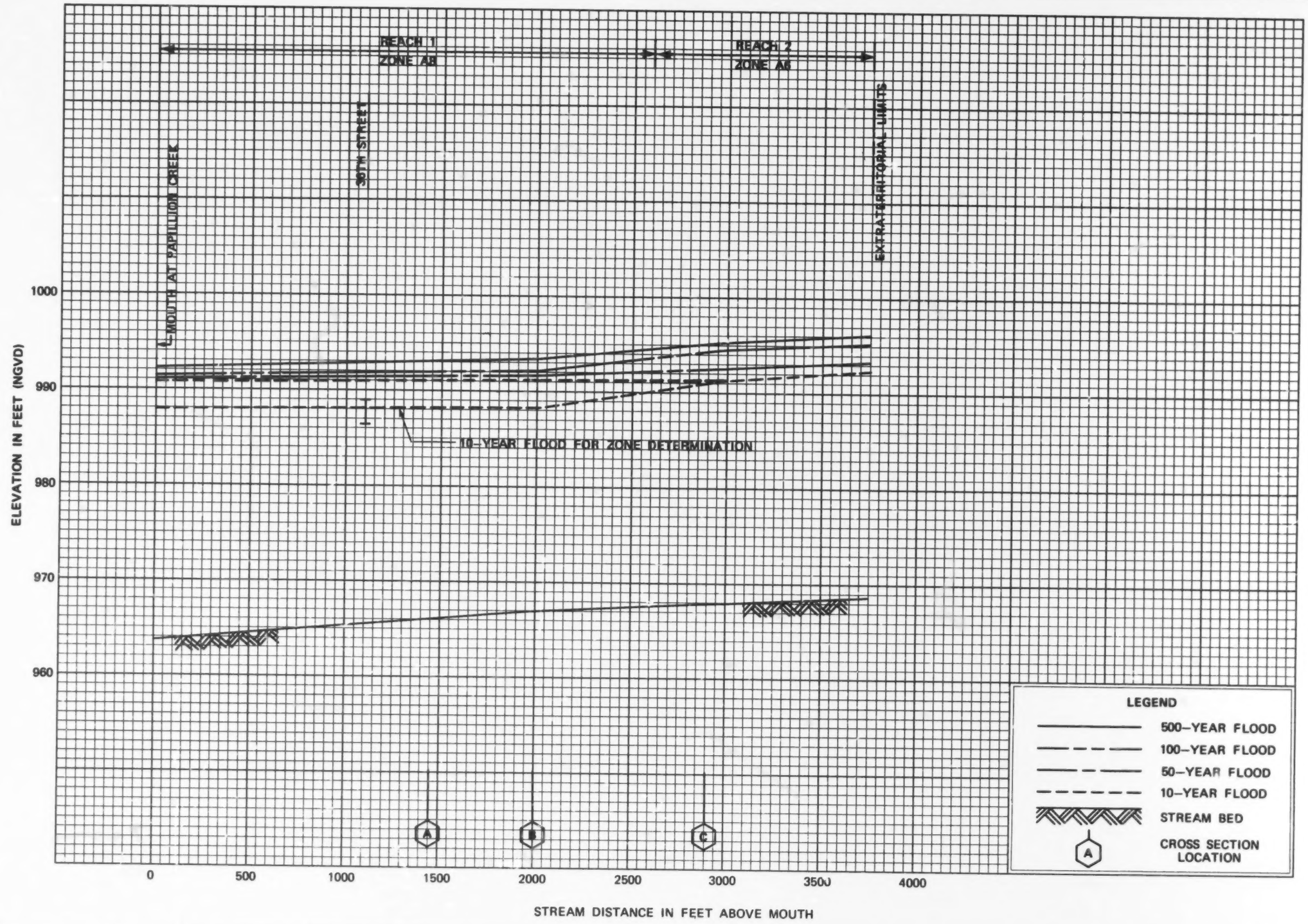

FLOOD PROFILES

WEST BRANCH PAPILLION CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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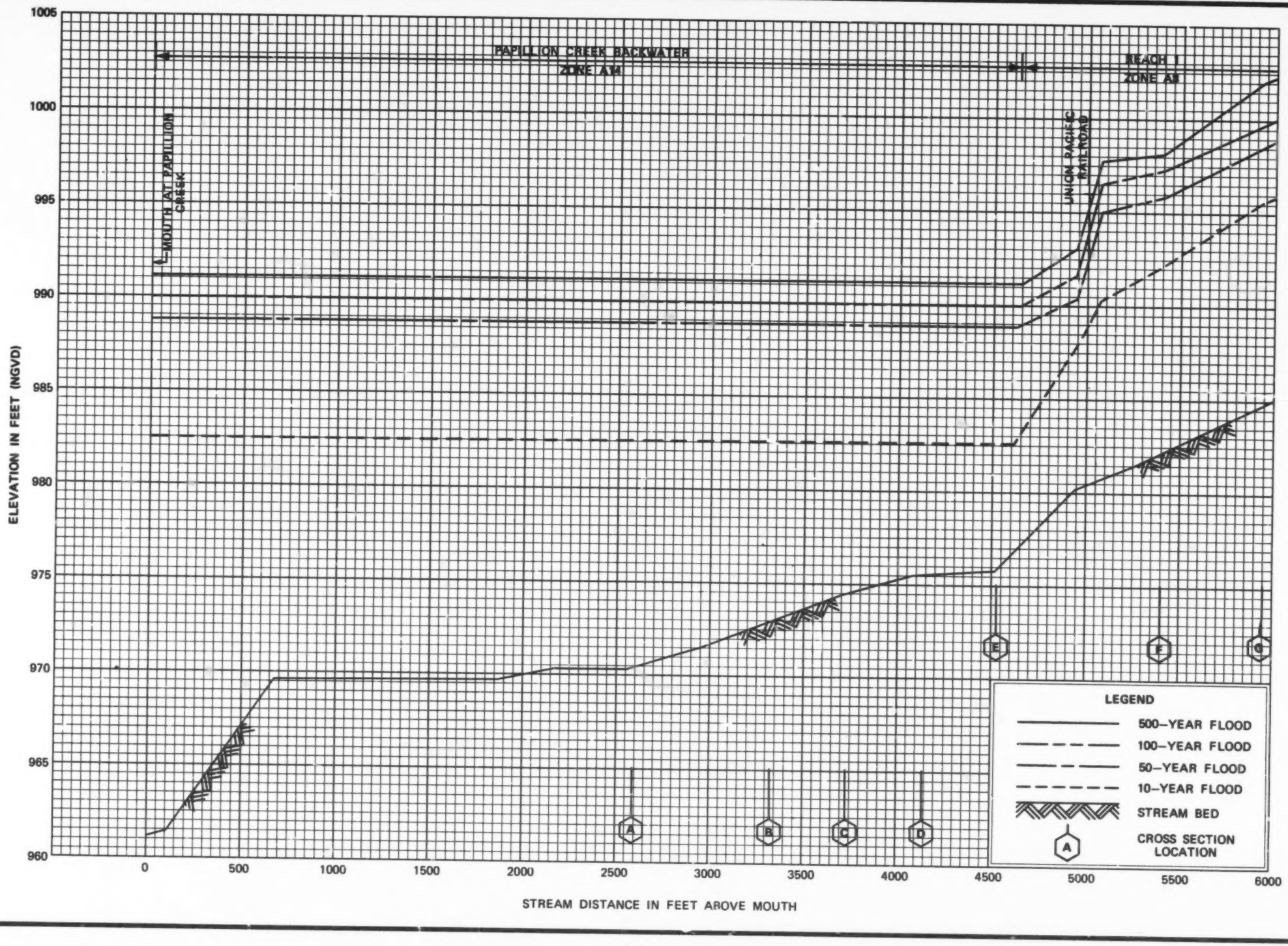

FLOOD PROFILES

MUD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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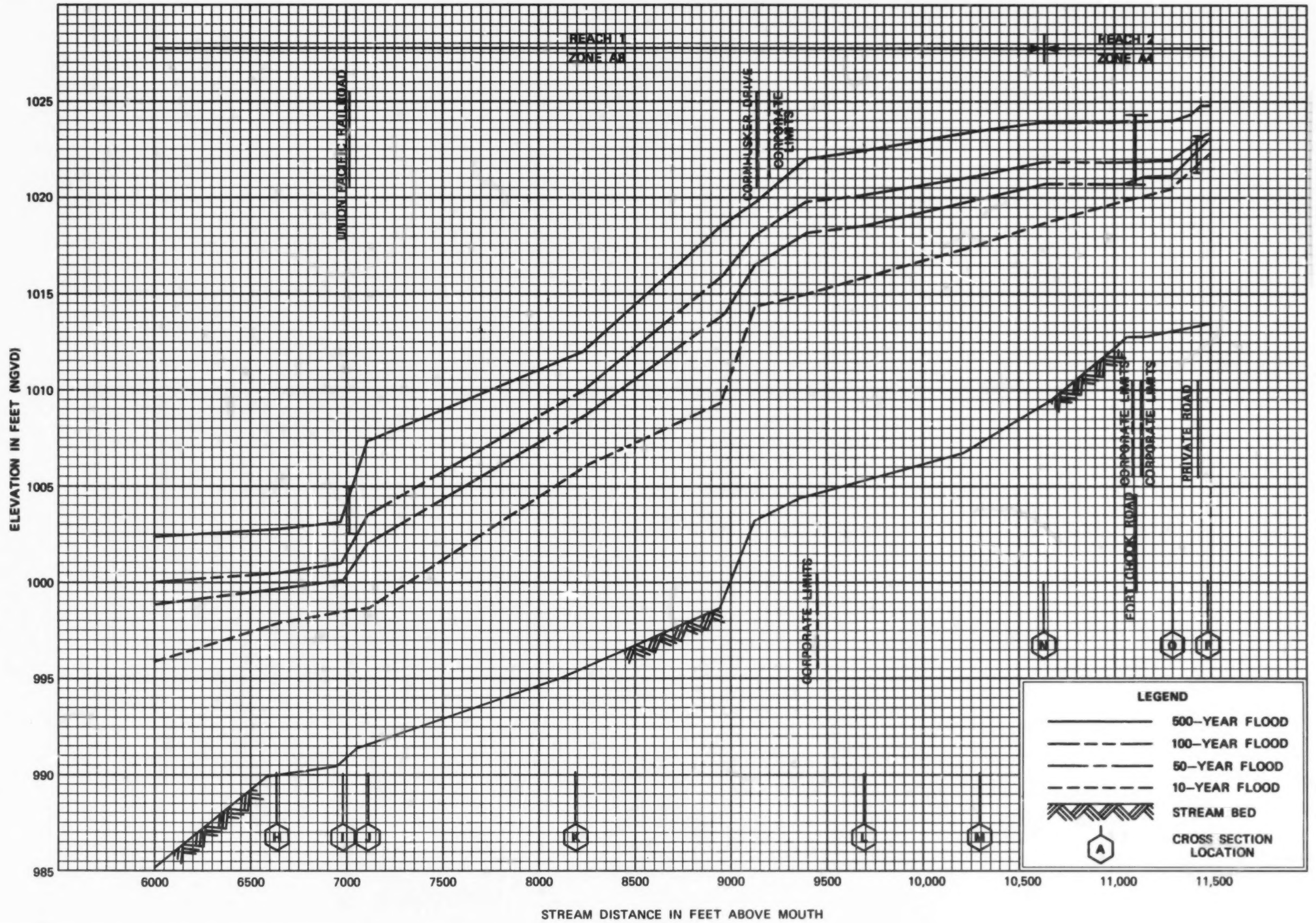

FLOOD PROFILES

MUD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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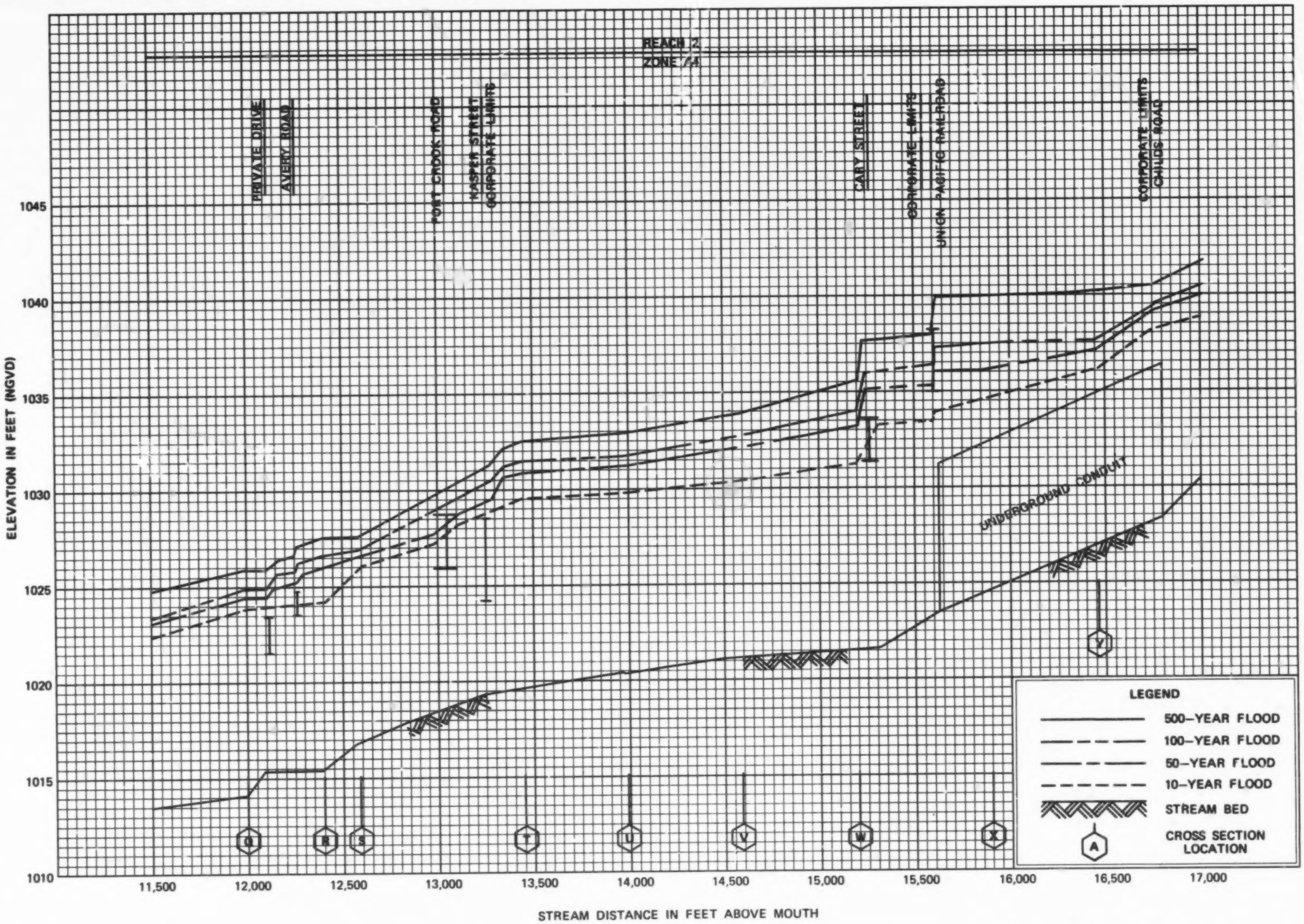

FLOOD PROFILES

MUD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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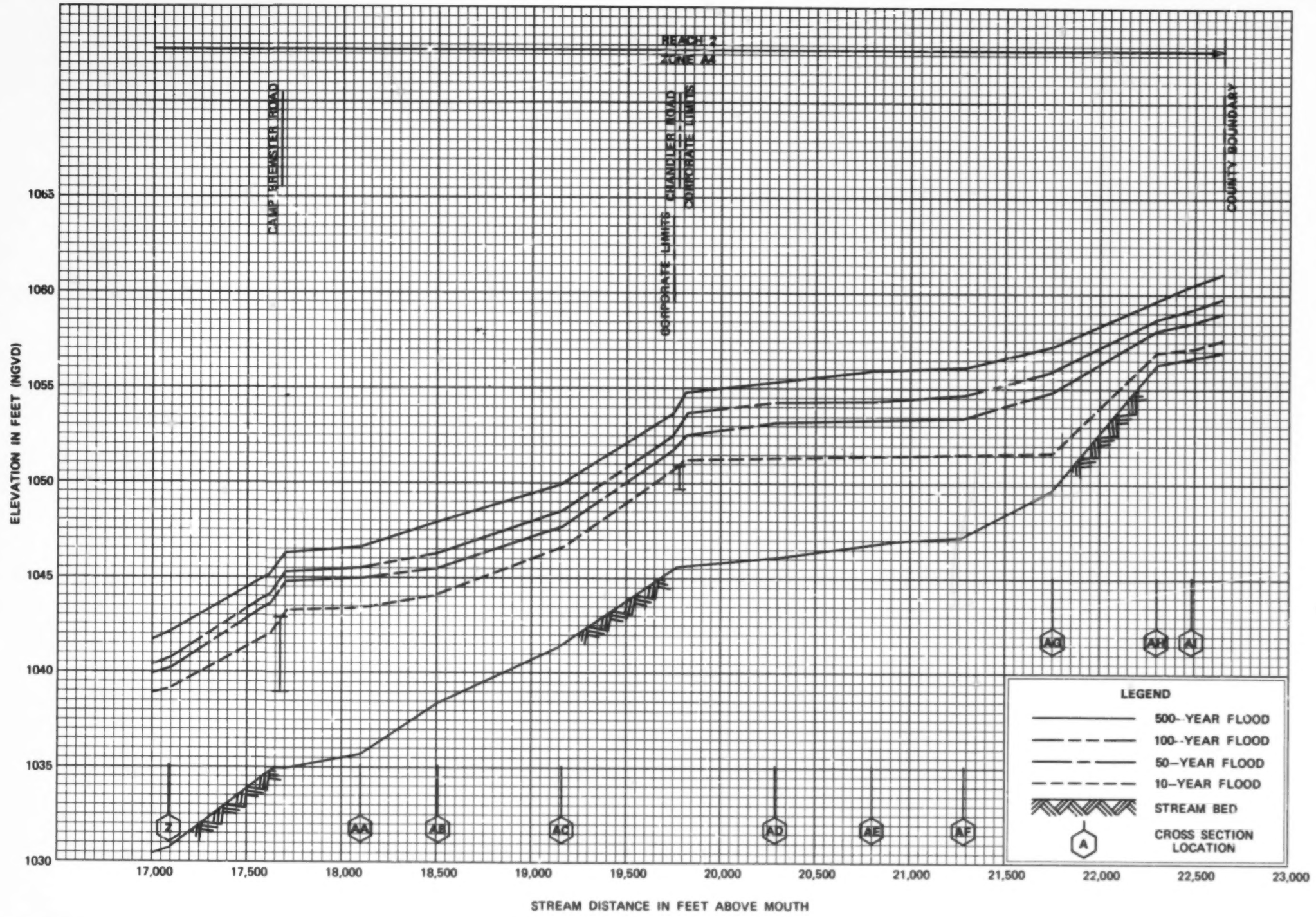

FLOOD PROFILES

MUD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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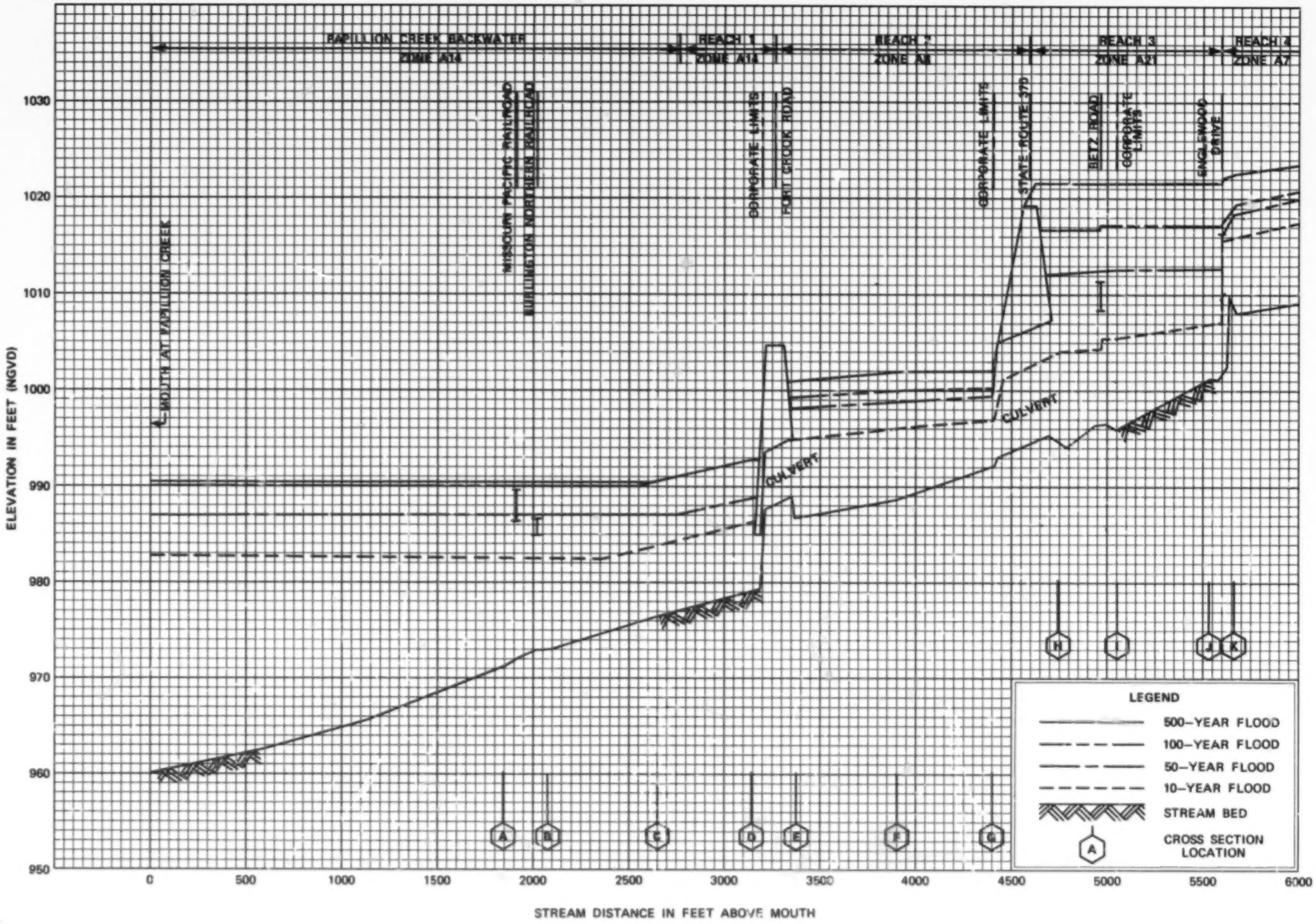

FLOOD PROFILES

BETZ ROAD DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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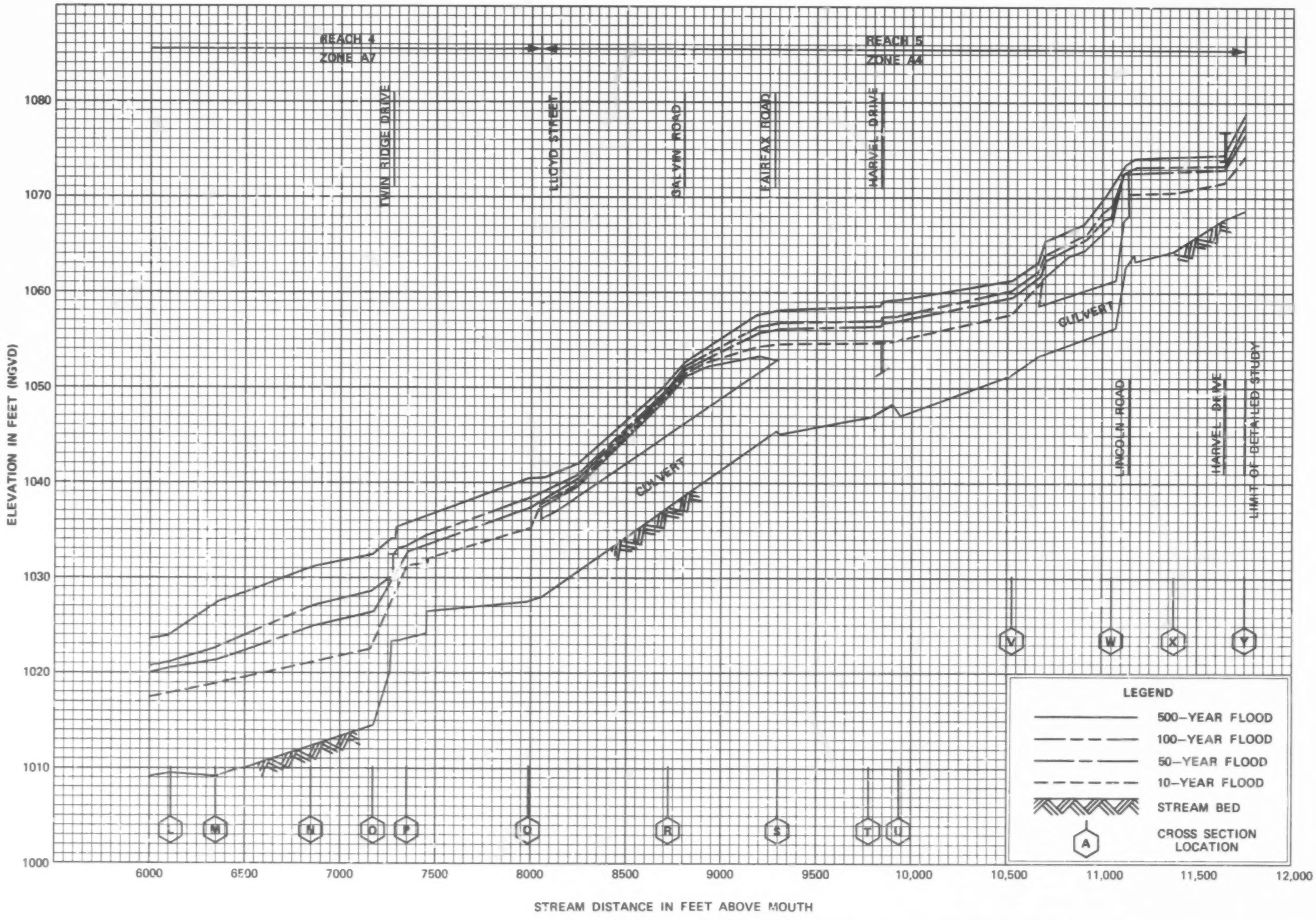

FLOOD PROFILES

BETZ ROAD DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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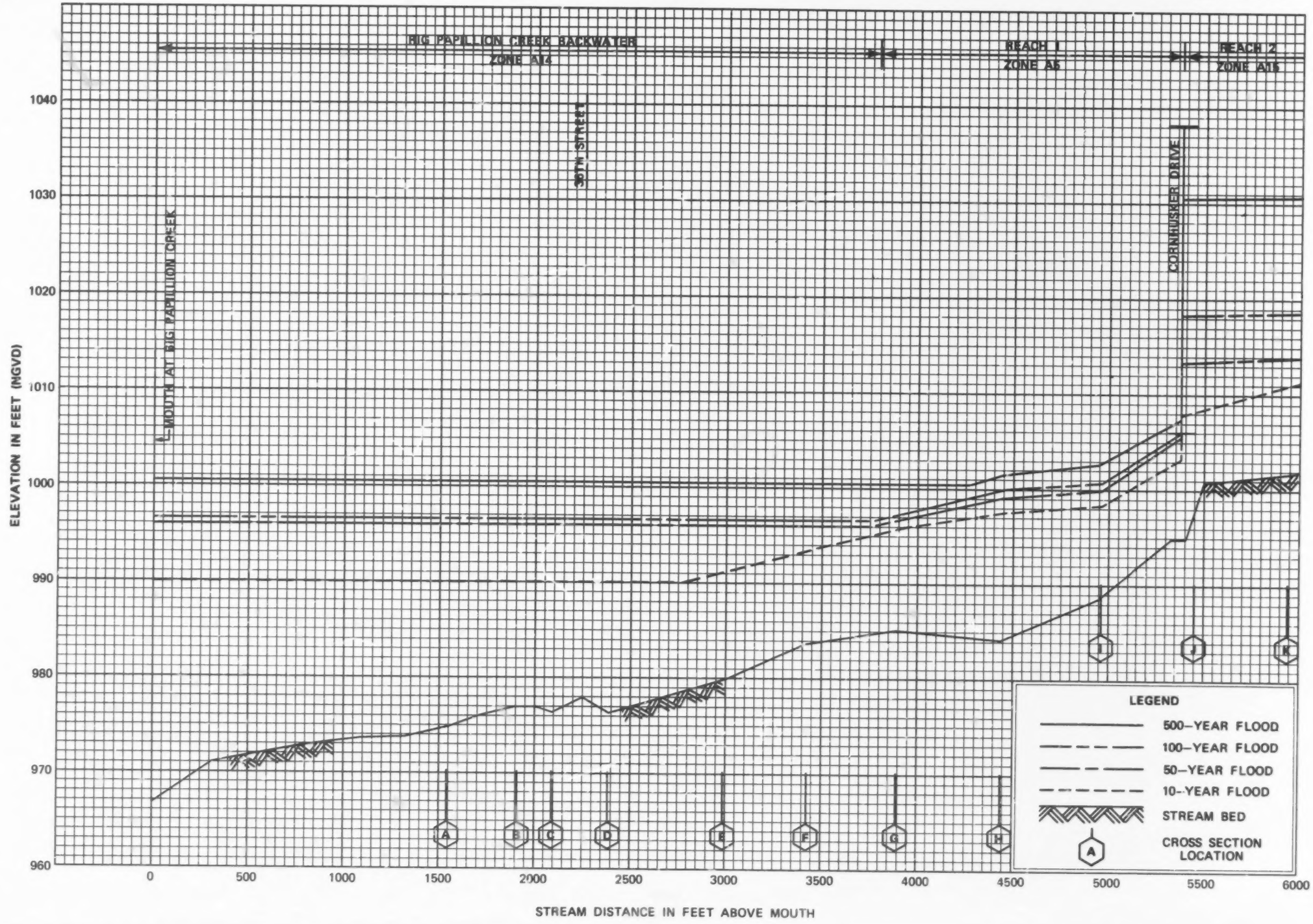

FLOOD PROFILES

SQUAW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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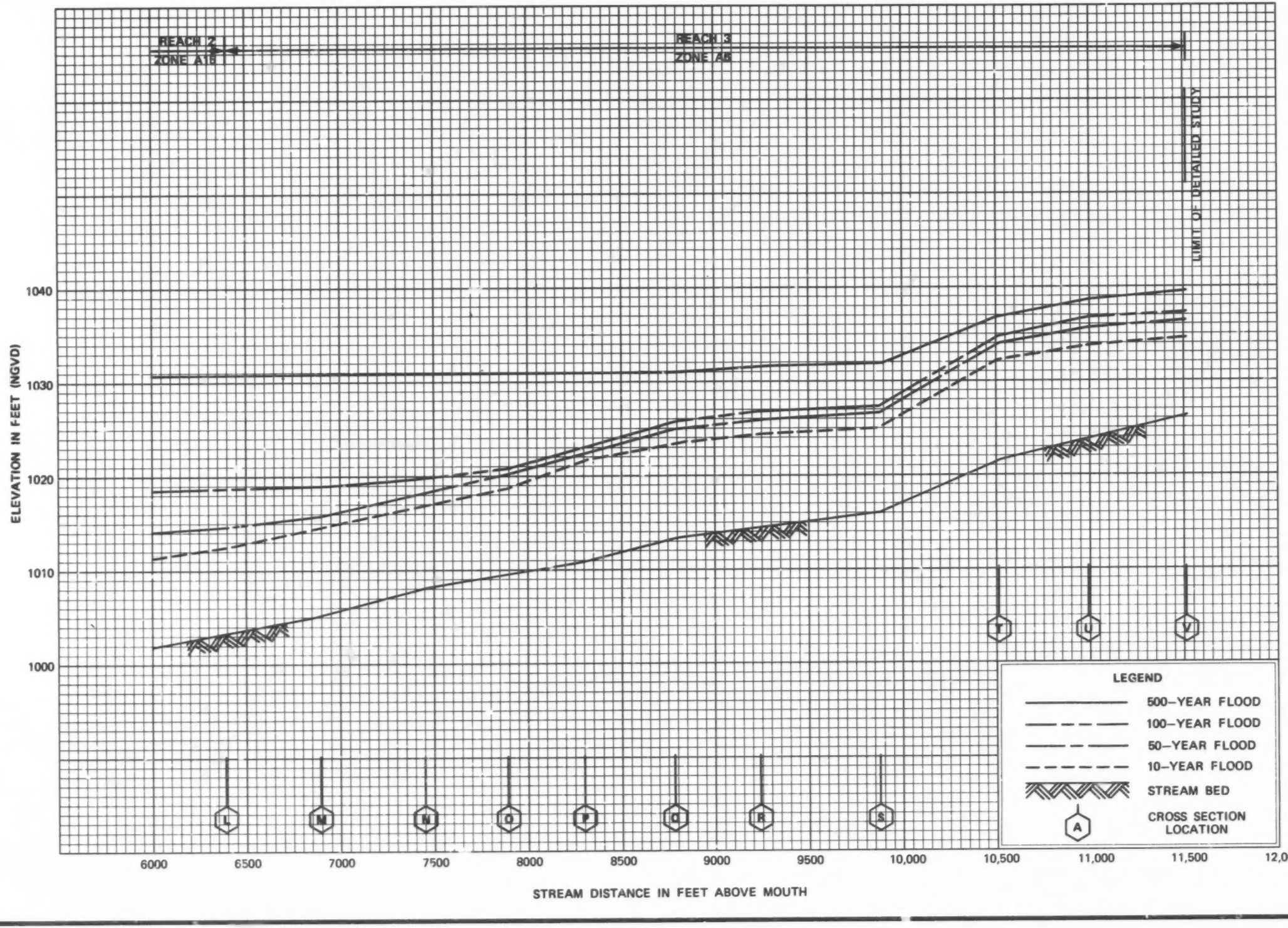

FLOOD PROFILES

SQUAW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BELLEVUE, NE
(SARPY CO.)

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